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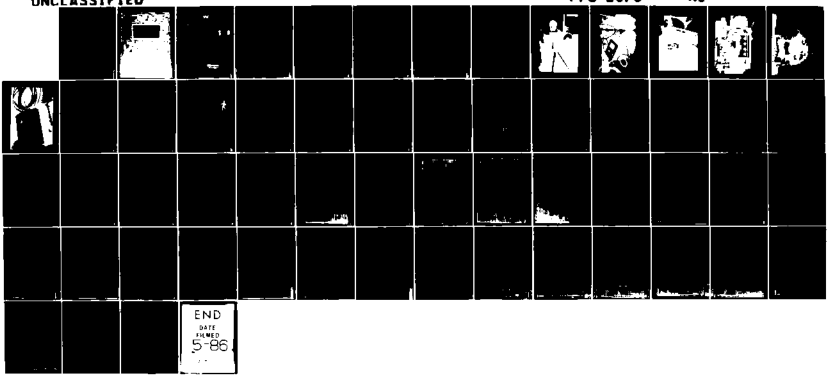

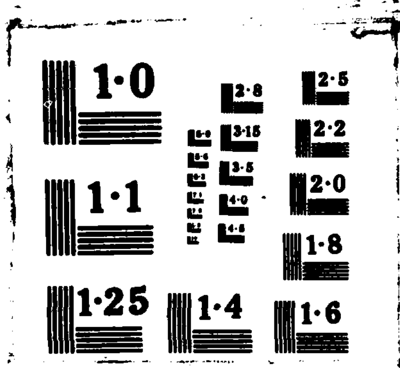
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SAIC

Science Applications International Corporation

AD-A166 546

ELECTRO-OPTICAL DEVELOPMENT SYSTEM

FINAL REPORT

Contract DAAK70-84-C-0034
Period of Performance: 04/16/84 through 09/30/85

Submitted to: Night Vision and Electro-Optical Laboratory
Attention: William Johnson
SPO-SID-DELNV-SD
MERADCOM
Ft. Belvoir, VA 22060

Prepared by: [illegible]
Science Applications International Corp.
[illegible] Suite 1100
[illegible]

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1.0 INTRODUCTION

This final report describes the successful delivery of all required items under the contract, as well as additional work not originally anticipated at the time the proposal was written. The relatively long time delay of approximately ten months in contract award meant that customer requirements had evolved since the proposal was prepared. Science Applications International Corporation (SAIC) provided flexible response in order to satisfy evolving requirements, as SAIC has done during previous contracts.

All requested tasks were completed, but not without technical challenges. The sections which follow describe each of these tasks.

2.0 LLLTV WIDE-FIELD SMALL-APERTURE SYSTEM

The original statement of work called for the development of an integrated system utilizing micro-channel plate (MCP) image intensification of a solid-state detector array with C-mount interface to a small diameter cystoscope. This system was delivered utilizing GFE customer components, since the customer had acquired these components during the contracting process. This GFE mode of satisfying the requirement was suggested by the customer in order to free contract resources for other tasks.

3.0 INTERFACES FOR PORTAL APERTURE IMAGE REFOCUSING (PAIR)

Five complete PAIR units were built and delivered. This task required devising a sophisticated optical design utilizing nine optical elements, in addition to a unique mechanical housing and coupling mechanism. The entire task was completed within three months due to a pressing customer application. The design details of this device are not included here at customer request.

4.0 FAST TELEPHOTO LENS

The requirement for a low focal ratio telephoto lens to be used with a low light level television (LLLTV) camera was first addressed by designing a Wright camera configuration (Figure 1A). The fabrication of the corrector plate and mirror was attempted by a private local optical shop specializing in aspheres. The company was unsuccessful in their attempt to fabricate the elements for a fast (F = 2) Wright, however, due to the need to manufacture optical elements differing from a spherical surface by about 300 fringes. A different configuration proved necessary.

A successful F = 1.5 telephoto lens was fabricated using the Schmidt camera configuration of Figure 1B. This fast focal ratio results in a 78% brightness increase over the Wright design, and an even larger advantage when compared to commercially available optics in the 300 millimeter or longer focal lengths. The one disadvantage of the system is the long tube length which is twice the focal length. Design studies have indicated that good performance would be available over the desired field of view from a shortened Schmidt configuration with total physical length comparable to the focal length, but it was not possible to try this under the present contract.

5.0 ALTITUDE-AZIMUTH MOUNTS

Two complete alt.-azimuth mounts were designed, fabricated, and delivered. The first was a prototype which exceeded customer requirements in that it had proportional joystick control with finer motion resolution than needed (Figures 2, 3, 4 and 5). The second version for field use was developed using customer feedback from experience with the prototype. The operational mount (Figures 6 and 7) weighs only about 4.5 pounds compared to 27 pounds for the prototype. This small mount uses a 4 pound control box with simple direction and motion rate controls. Preliminary drawings

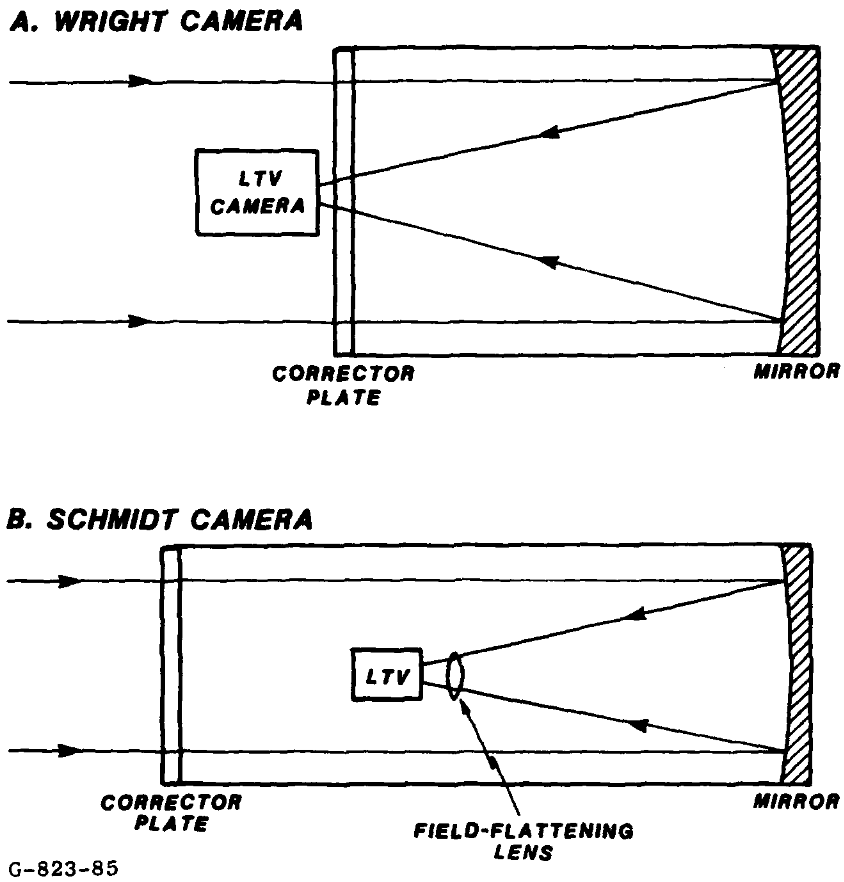

Figure 1. Fast Telephoto Lens Configurations

Figure 2. Prototype Alt.-Azimuth Mount

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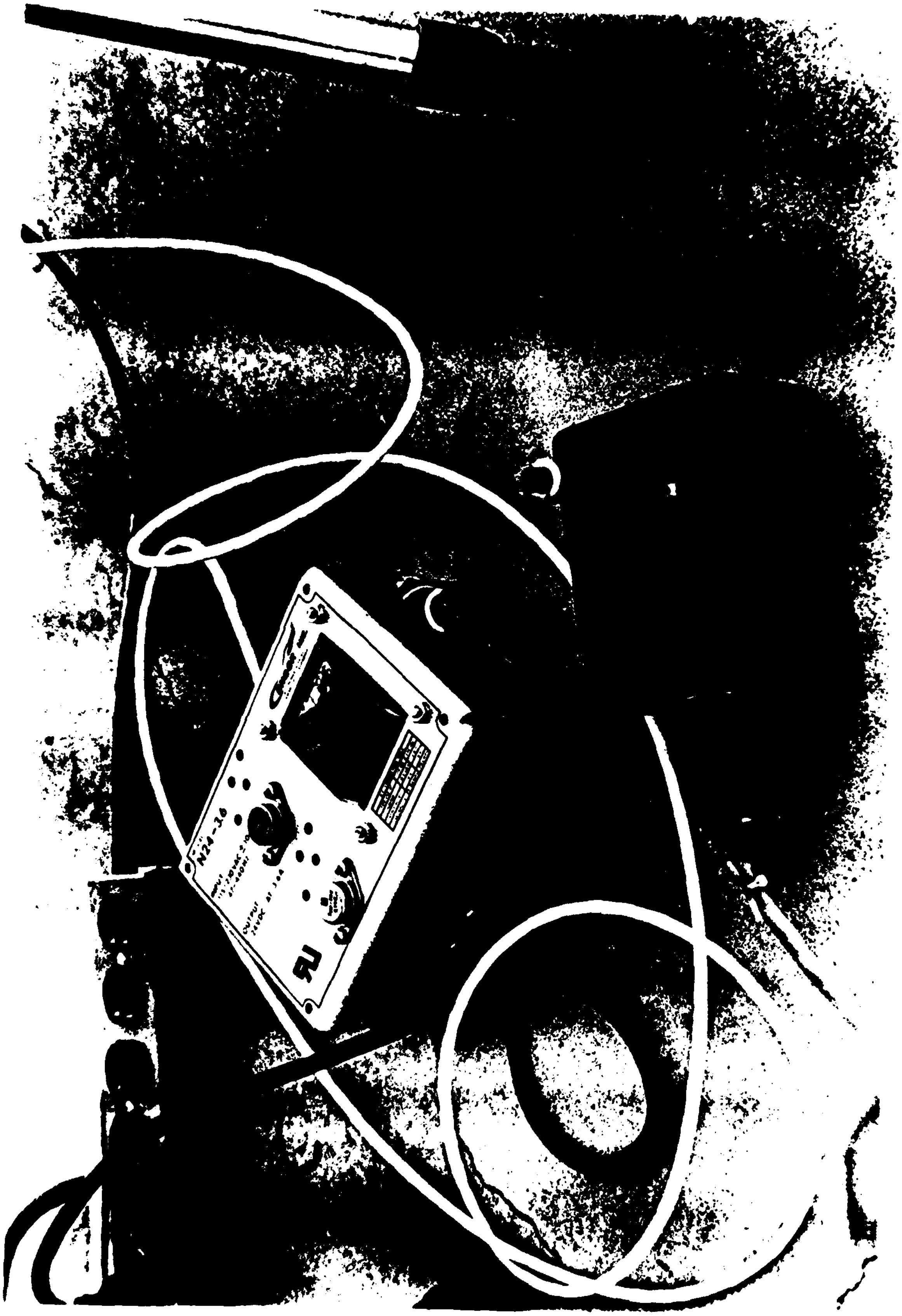

Figure 3. Prototype Proportional Joystick Control

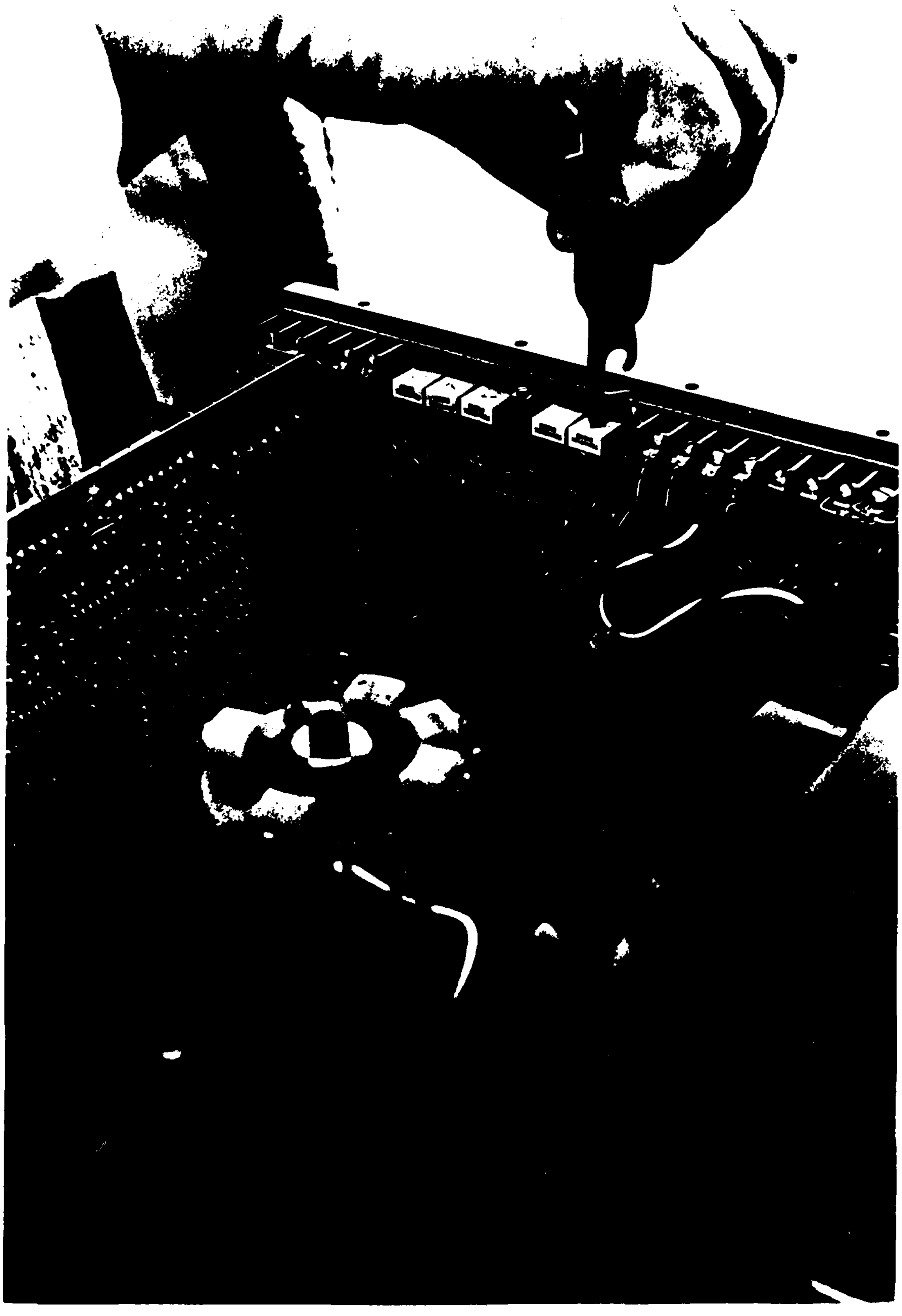

Figure 4. Prototype Mount With Cover Removed

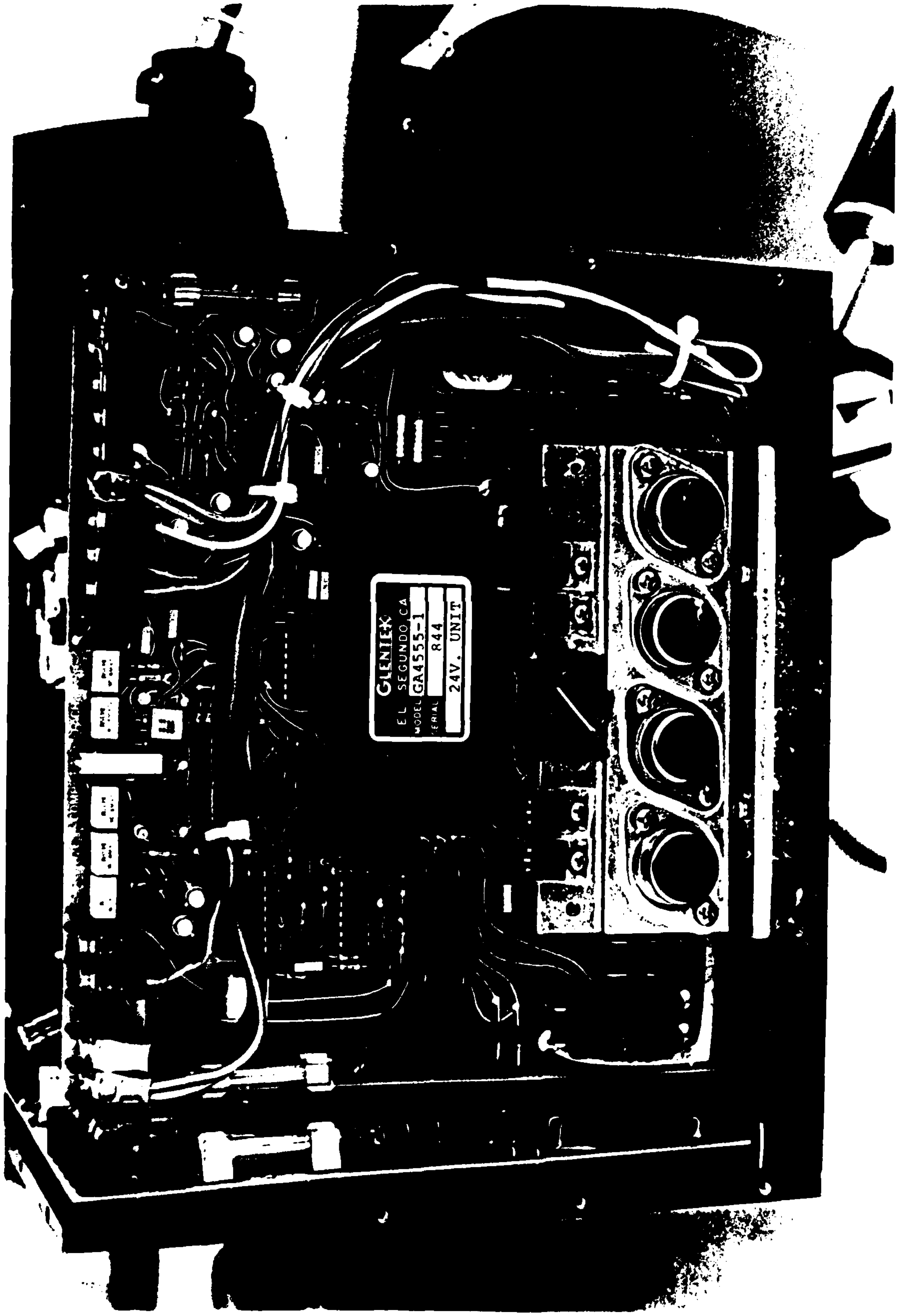

Figure 5. Internal Prototype Mount Electronics

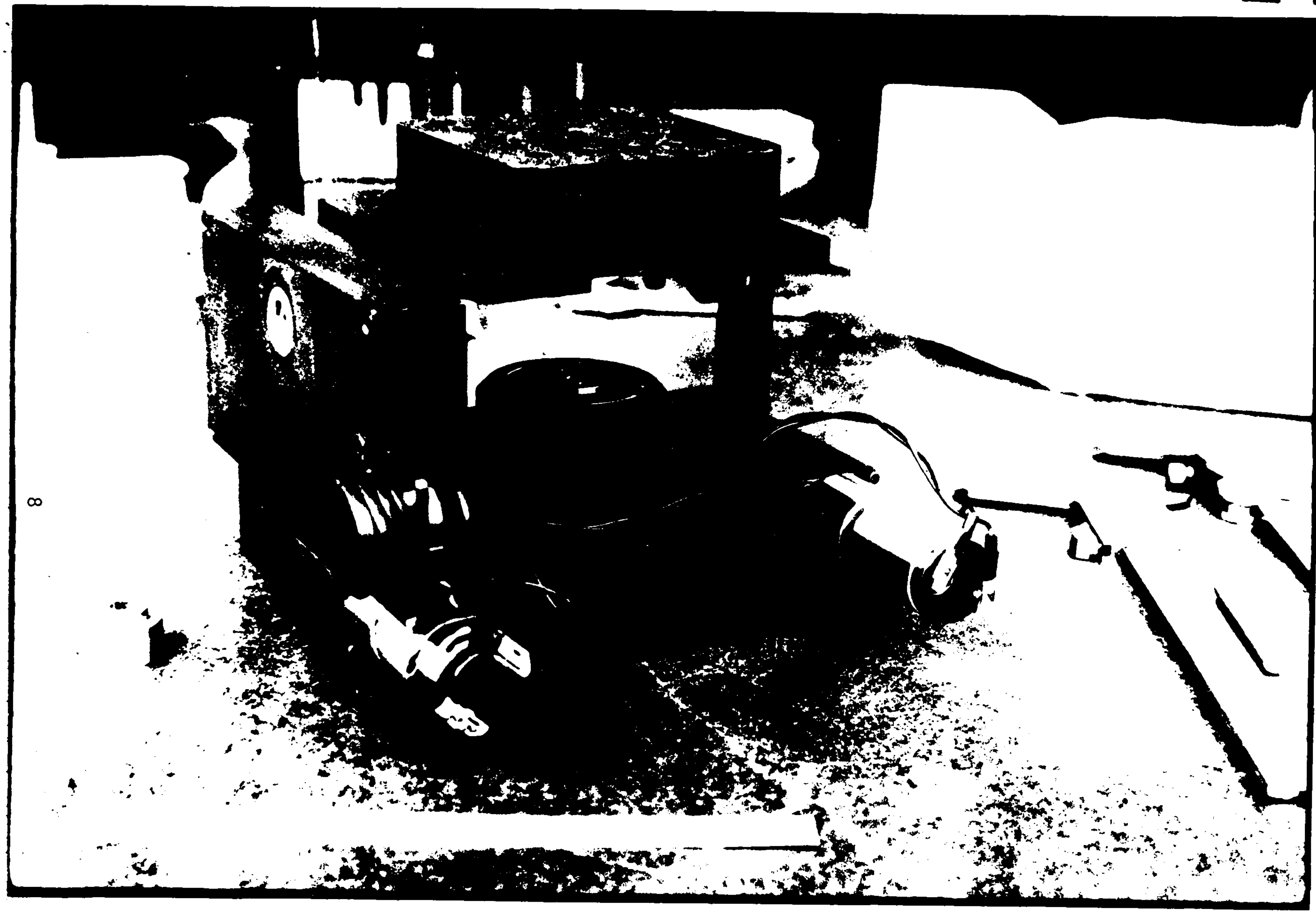

Figure 6. Small Operational Mount

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Figure 7. Control Box For Small Mount

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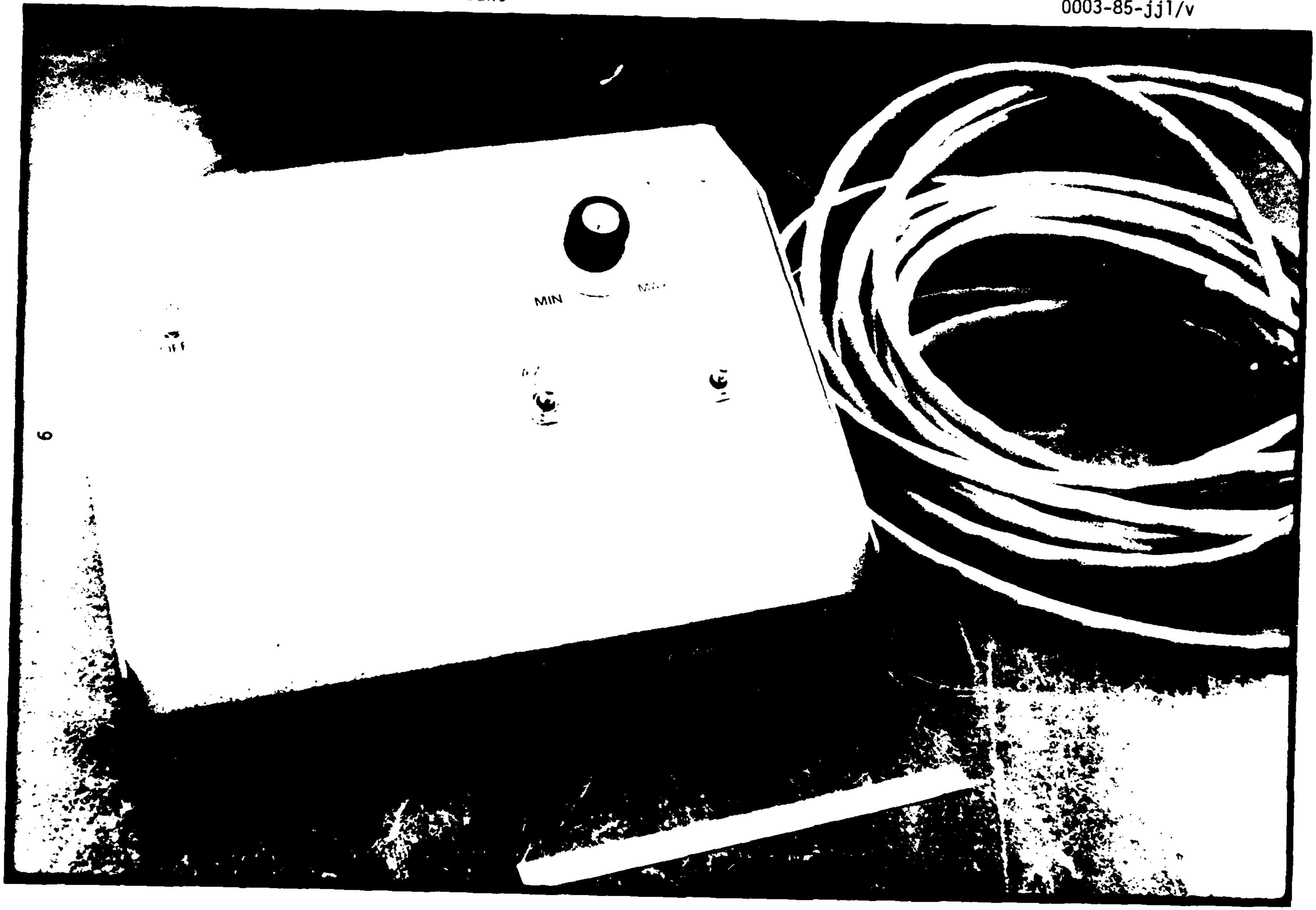

for the small mount are provided in Appendix B.

6.0 IMAGING SYSTEM AND HUMAN EYE PERFORMANCE MODELING

Appendix A details modeling in support of a customer requirement for covert near-infrared imaging.

7.0 DISCUSSION

Responsive support of diverse and evolving customer requirements has been provided including the design, development, and delivery of several new systems. Some of these systems, such as PAIR and the small alt.-azimuth mount are nearly fully developed, while the fast telephoto lens should be refined to reduce its size and decrease scattered light from off-axis sources.

APPENDIX A

MODELING OF SURVEILLANCE SENSORS AND MODELING OF THE HUMAN EYE FOR COVERT NEAR-INFRARED IMAGING

A.1 SUMMARY

It is desired to determine the feasibility of designing an active illuminator/near infrared imager combination which will allow the covert surveillance of humans. The infrared response of the eye extends somewhat further into the red than is often assumed. This eye response to about 1 micrometer wavelength [1] requires more attention to detail in solving the problem than might at first be supposed. An operational illumination system [2] in use for this purpose is in fact easily detected by the eye even though a filter which blocks essentially all of the light shortward of about 800 nanometers is used.

A radiometric model is constructed and exercised to determine if relatively simple modifications to existing equipment can be made which will solve the problem. It has been found that the use of a longer wavelength optical filter only increases the intensified television surveillance system advantage over the eye by about 3dB. The best solution available with the present illuminators is to increase the TV optical aperture area to 675 cm^2 (the equivalent of about an 11-inch clear aperture optic with central obstruction). This aperture will allow operation to a range of about 200 meters without exceeding the illuminator intensity which is detectable by the eye.

A.2 RADIOMETRIC MODEL

Part of the difficulty in acieving covert illumination arises due to the direct illumination of the human in Figure A1. The eye is looking directly down the collimated searchlight beam, whereas the low light level television (L^3TV) must use diffusely reflected indirect illumination. The monochromatic power incident on the eye is:

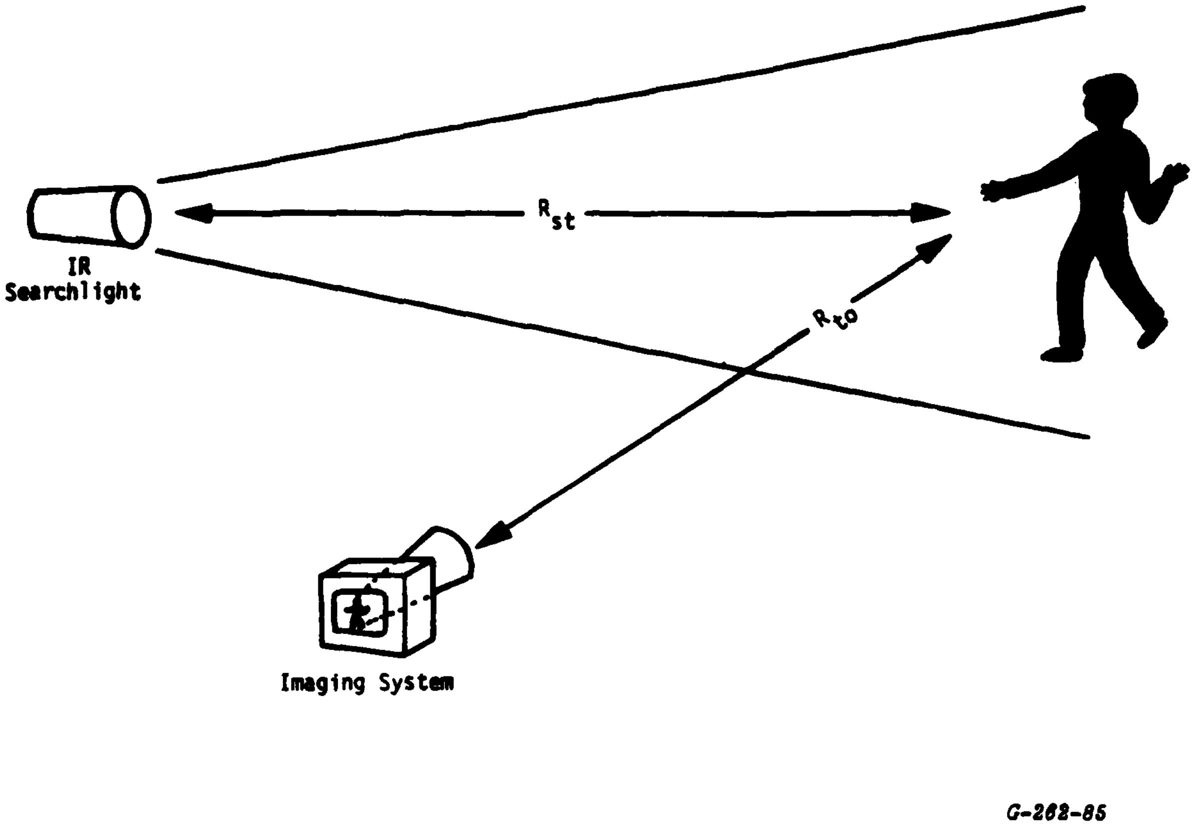

Figure A1. Problem Geometry

$$\Phi_{eye}(\lambda) = \frac{L_s(\lambda)\tau_f(\lambda)A_s A_{eye}}{R^2_{st}} \quad , \qquad (1)$$

where: $L_s(\lambda)$ is the radiance of the searchlight source,
$\tau_f(\lambda)$ is the transmissivity of the IR searchlight filter,
A_s is the source area,
A_{eye} is the eye aperture area, and
R_{st} is the searchlight to eye distance.

The power incident on a pixel sized region of the L^3TV photocathode can be decomposed to clarify the nature of the indirect illumination:

$$\Phi_{pc}(\lambda) = (\text{power incident on a target pixel})$$

$$\times \frac{(\text{target pixel reflectivity})}{(\text{reflectance solid angle})}$$

$$\times (\text{solid angle of } L^3\text{TV optics at the target}) \quad . \qquad (2)$$

In calculating the power incident on a target pixel, some concern may arise over the highly collimated nature of the searchlight beam. This collimation might be thought to invalidate the apparent R^{-2} dependence which arises in radiative transfer relations similar to Equation (1). It is less likely to include an error in the radiometric model if an expression such as (1) is thought of in terms of geometrical partitioning of the radiant power:

$$\Phi_{eye}(\lambda) = (\text{power emitted by the searchlight})$$

$$\times (\text{fraction of power intercepted by the eye})$$

$$= \Phi_s(\lambda)\left(\frac{\Omega_{eye}}{\Omega_s}\right) = \left(\frac{\Phi_s(\lambda)}{\Omega_s}\right)\left(\Omega_{eye}\right)$$

$$= \left(L_s(\lambda)\tau_f(\lambda)A_s\right)\left(\frac{A_{eye}}{R^2_{st}}\right) \quad , \qquad (3)$$

where: Ω_{eye} is the solid angle subtended by the eye at the searchlight, and

Ω_s is the solid angle into which the searchlight emits.

It is assumed here that the searchlight emits uniformly throughout Ω_s to eliminate the necessity of integrating over angular dependence. It is then apparent that as long as

$$\frac{\Omega_{eye}}{\Omega_s} \leq 1 \quad , \tag{4}$$

the R^{-2} dependence of Equation (3) which arises from the calculation of Ω_{eye} holds. Similarly, Equation (2) may be expressed:

$$\Phi_{pc}(\lambda) = \left(\frac{L_s(\lambda)\tau_f(\lambda)A_sA_t}{R_{st}^2}\right)\left(\frac{\rho_t(\lambda)}{\pi}\right)\left(\frac{A_0}{R_{to}^2}\right) \quad , \tag{5}$$

where: A_t is the target pixel area,

$\rho_t(\lambda)$ is the target pixel reflectivity,

A_0 is the area of the L^3TV optics,

R_{to} is the target to L^3TV distance,

and it is assumed that

$$\frac{\Omega_t}{\Omega_s} \leq 1 \quad , \tag{6}$$

with uniform illumination throughout Ω_s.

The signal-to-noise ratio for the eye looking at the searchlight as well as for the L^3TV detecting the target reflectance signal can now be calculated. The L^3TV is assumed to be microchannel plate intensified and quantum noise limited in the sense that [3]:

$$SNR_{L^3TV} = \sqrt{n \, \eta_{pc} \, F_{MCP}} \quad , \tag{7}$$

where: n is the number of photons incident on a pixel sized area

of the photocathode,

η_{pc} is the photocathode quantum efficiency, and

F_{MCP} is the microchannel plate fill factor.

The number of photons is:

$$n = \frac{\lambda \Phi_{pc}(\lambda)\Delta t}{hc} \quad , \tag{8}$$

where: Δt is the integration time,

h is Planck's constant (6.63×10^{-34} Jsec),

c is the speed of light, and

$\Phi_{pc}(\lambda)$ is given by Equation (5).

The final signal-to-noise expression integrated over the spectral response of the L^3TV is:

$$SNR_{L^3TV} = \left[\Delta t \int_0^{\infty} \frac{\lambda L_s(\lambda)\tau_f(\lambda)A_s A_t A_0 \rho_t(\lambda)\eta_{pc}(\lambda)F_{MCP}}{\pi hc R_{st}^2 R_{to}^2} \, d\lambda \right]^{1/2} . \tag{9}$$

The signal-to-noise for the eye is taken to be:

$$SNR_{eye} = \left[\int_0^{\infty} \frac{\Phi_{eye}(\lambda)}{T_{eye}(\lambda)} \, d\lambda \right]^{1/2} \quad , \tag{10}$$

where: $T_{eye}(\lambda)$ is the eye threshold.

Therefore,

$$SNR_{eye} = \left[\int_0^{\infty} \frac{L_s(\lambda)\tau_f(\lambda)A_s A_{eye}}{T_{eye}(\lambda) R_{st}^2} \, d\lambda \right]^{1/2} . \tag{11}$$

While the eye is very much less sensitive than the L^3TV at wavelengths longer than 700 nanometers, the geometric advantage most

clearly seen in the R^{-2} dependence of Equation (11) versus the R^{-4} dependence of Equation (9) indicates some of the difficulty in solving the problem.

A signal-to-noise ratio of little more than 1 may allow eye detection of the searchlight, while the L^3TV must provide a somewhat higher SNR if identification with a high level of confidence is required. It is reasonable to require that the L^3TV SNR exceed 6, or 20 log (6) = 15.6 dB.

A.3 DATA

The spectral intensity of the xenon searchlight source used in the present operational system will be estimated using Figure A2. The SB-100 searchlight draws 20 amperes at 12 volts, or 240 watts, and is collimated approximately 10x. The figure is measured from an uncollimated 5,000 watt xenon source. Therefore, a scaling factor of 24,000/5,000 will be applied to the vertical axis.

The search light filter is a Schott RG 830 shown in Figure A3. The RG 850 filter can also be modeled.

The photocathode can be modeled with the use of Figure A4 which illustrates the spectral response of the XYBION camera currently in use. A negative electron affinity photocathode device would have increased red response and be more useful for this particular application.

The spectral sensitivity threshold of the human eye is obtained by normalizing Figure A5 to 3×10^{-16} watts at 510 nanometers [1].

Choosing nominal values for the remaining unknowns in Equations (9) and (11):

Δ_t = 1/30 second (interlaced RS-170)
A_t = 1 cm^2 (for facial identification)

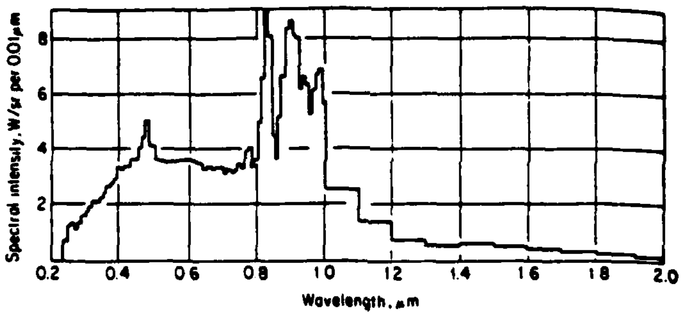

Figure A2. Xenon Lamp Spectral Intensity [4]

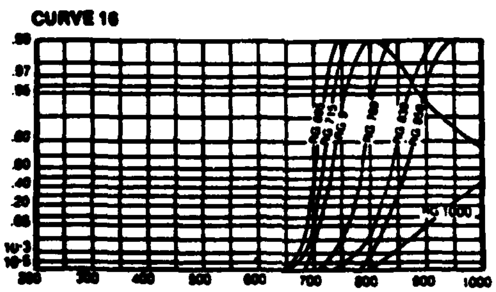

Figure A3. Schott Glass Filter Transmission [5]

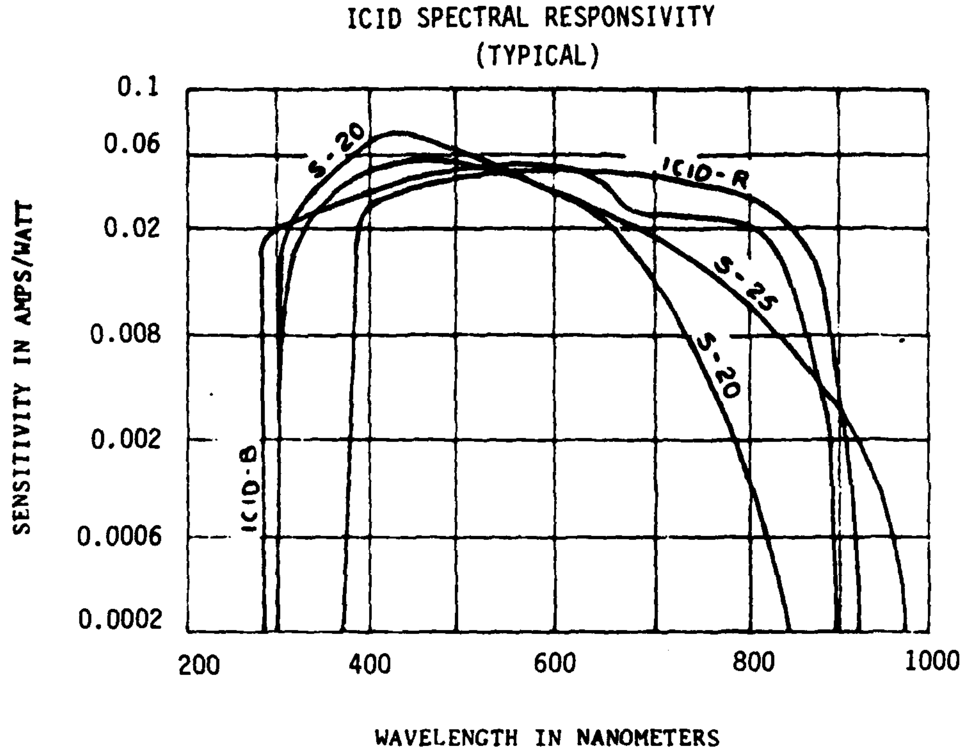

Figure A4. Spectral Response of the XYBION Camera (ICID-R) Compared to Other Conventional Photocathodes

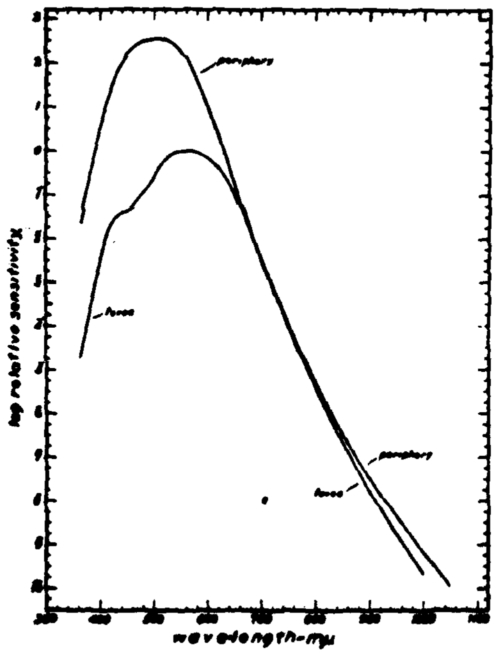

Figure A5. Spectral Sensitivity of the Human Eye [1]

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$A_0 = 75\ cm^2$

$\rho_t(\lambda) = 0.1$

$F_{MCP} = 0.8$

$A_{eye} = 40\ mm^2$ (dark adapted)

A.4 MODELING RESULTS

Figure A6 is an overview of the surveillance system operation to ranges of 200 meters. The fact that the camera dynamic range will not accommodate some of the high SNR's displayed has been ignored to illustrate the functional form of SNR with distance. Applying a fixed SNR ceiling would produce a flat plateau in the high SNR region. Examination of Figure A6 reveals an R^{-2} SNR dependence along the axes and an R^{-4} dependence along the diagonal from the origin to the (200,200) point.

The amount by which the searchlight brightness exceeds the dark-adapted eye threshold is shown as a function of eye to illuminator range in Figure A7. The light source is easily visible under favorable conditions at ranges in excess of 200 meters.

The quantity of interest is the TV SNR when the searchlight intensity is decreased to equal the eye threshold at the target distance. This can be obtained with the present model by taking the difference (in dB space) between the diagonal of Figures A6 and A7. Figure A8 illustrates that for a 3½ inch aperture, the required 15.6 dB sensor advantage over the eye is achieved at a range of a little more than 40 meters for the present system (RG 830 filter). Figure A9 shows that this range approximately doubles for an aperture diameter doubling to 7 inches. This is expected since the ratio of TV SNR to eye SNR (Equations (9) through (11)) has an R^{-2} dependence and the aperture area has a D^2 dependence. Increasing the aperture to 11 inches generates tactically useful ranges as shown in Figure A10.

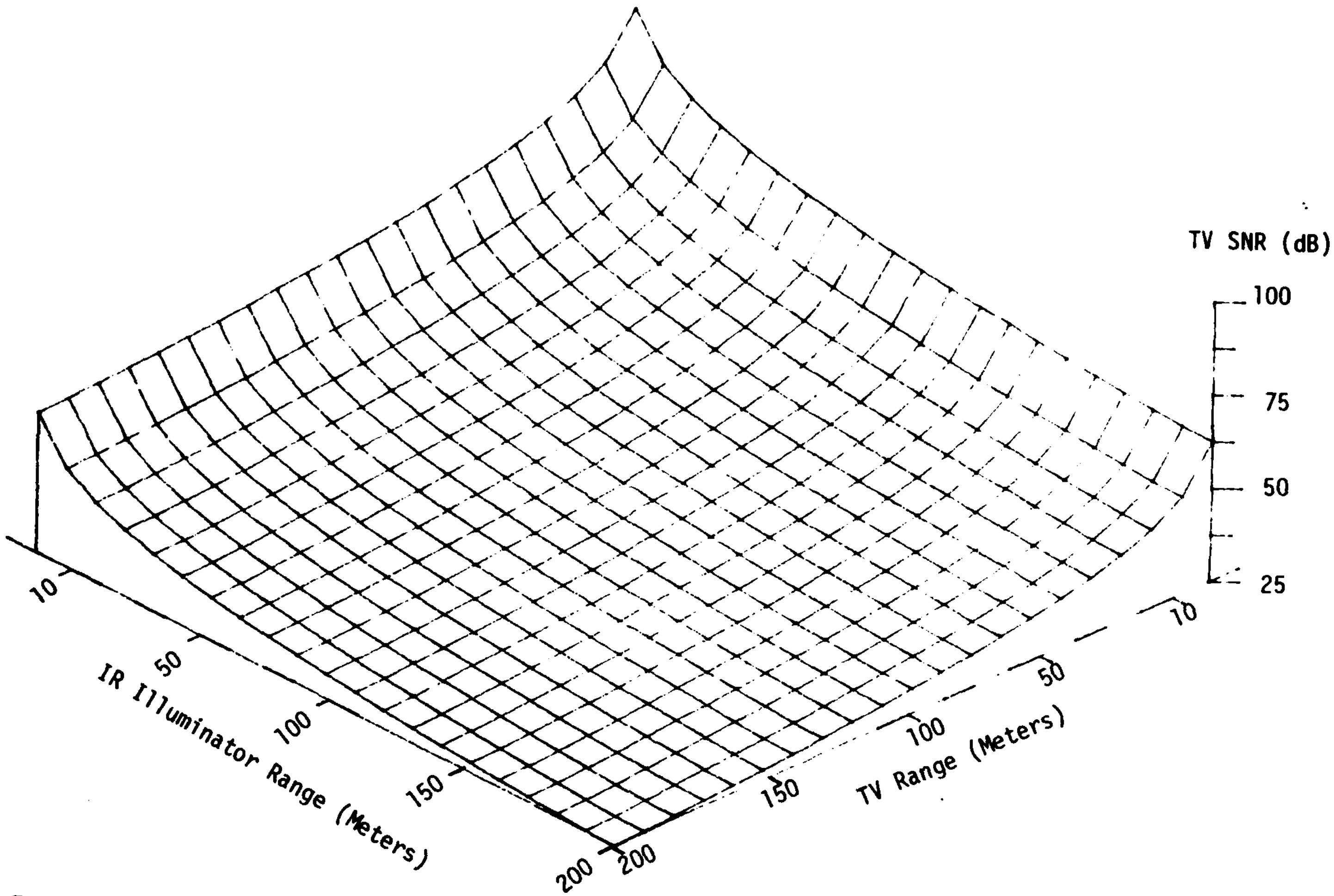

Figure A6. Intensified CCD TV Signal-to-Noise Ratio as a *Function of* TV Sensor Range and Illuminator Range

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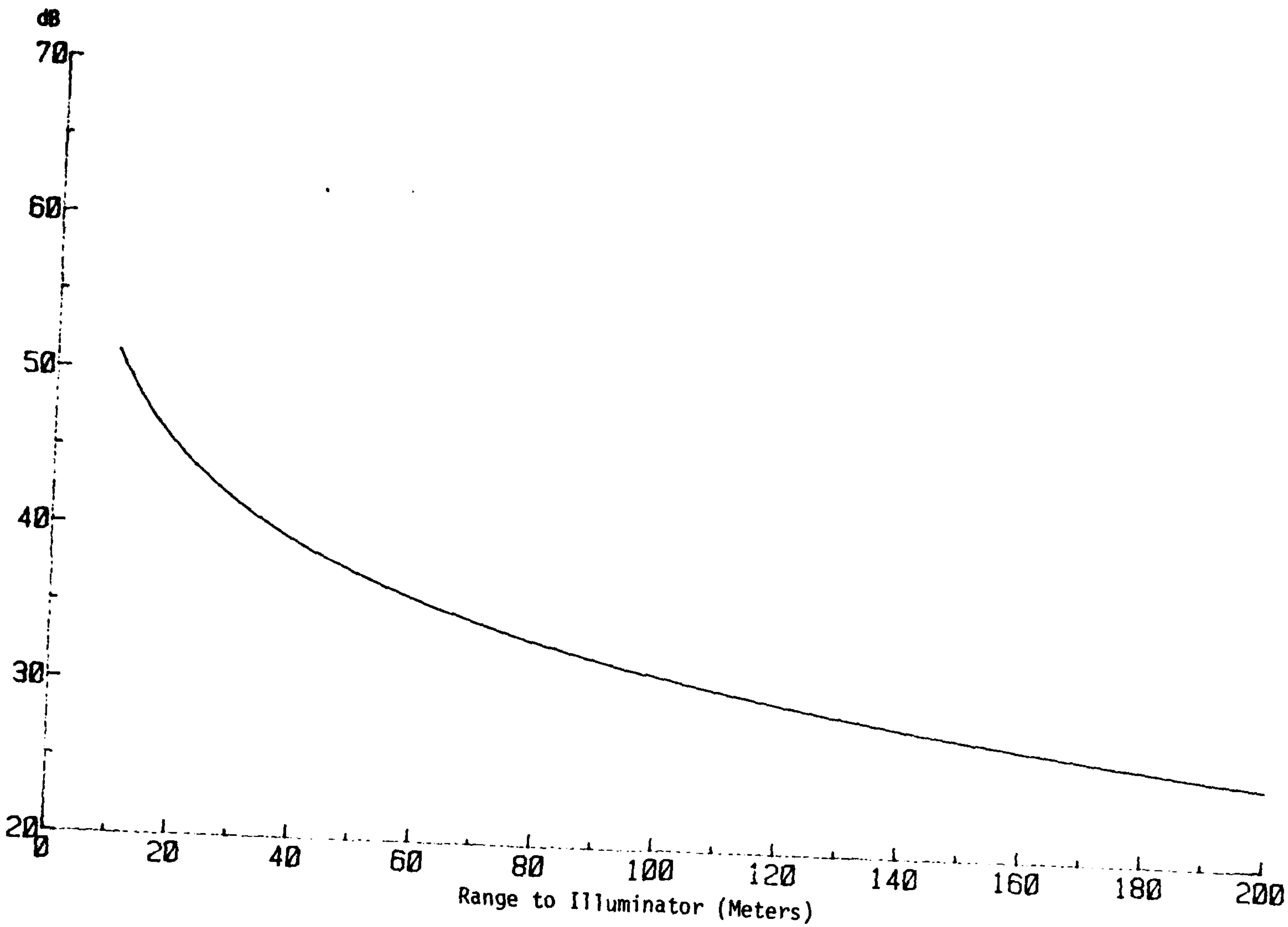

Figure A7. Signal-to-Eye-Threshold vs. Range to Illuminator

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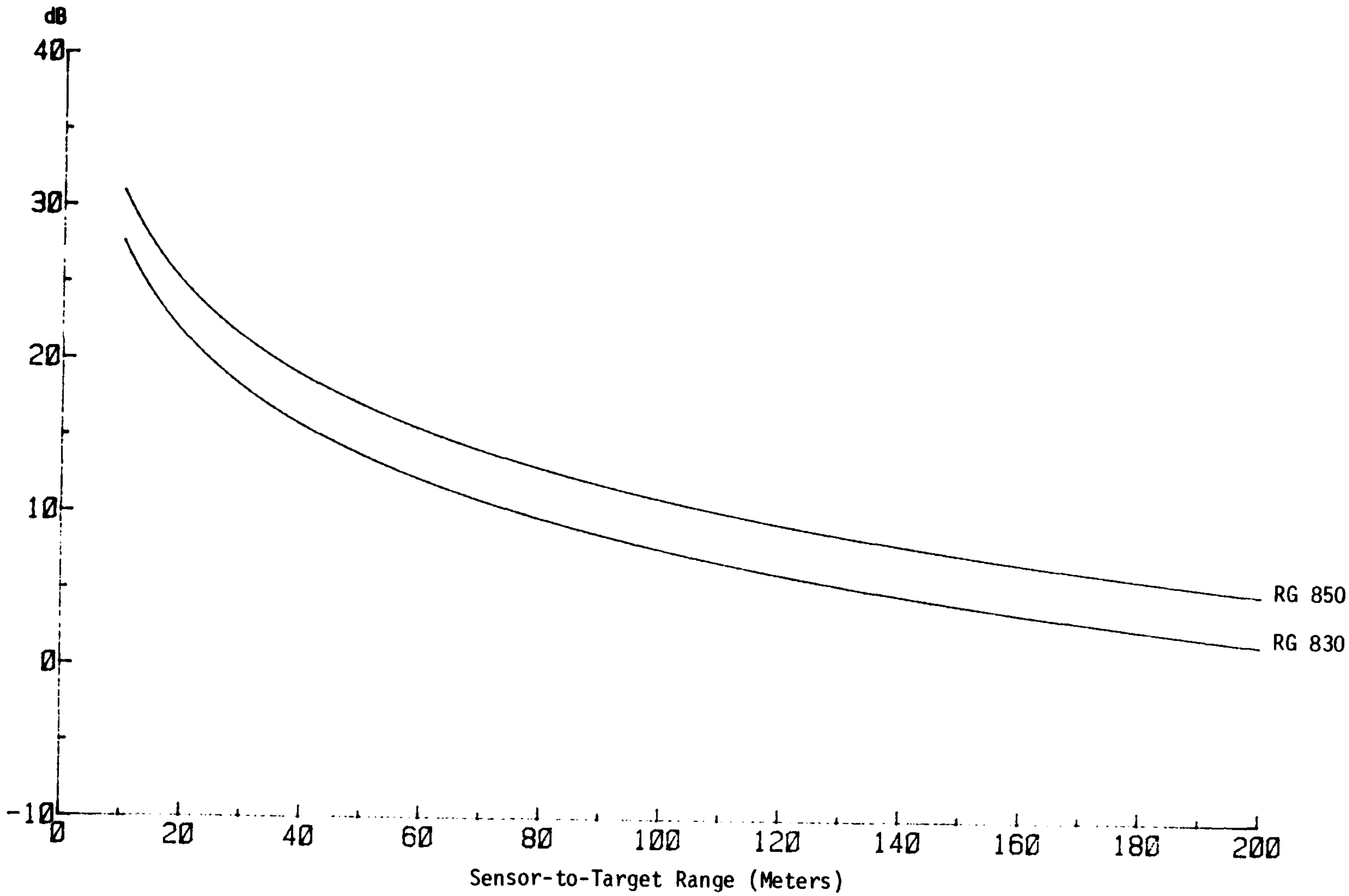

Figure A8. TV SNR Excess at the Sensor Over Eye Signal-to-Threshold at the Target for a Sensor of 75 cm^2 Area (3½ inch aperture with central obstruction)

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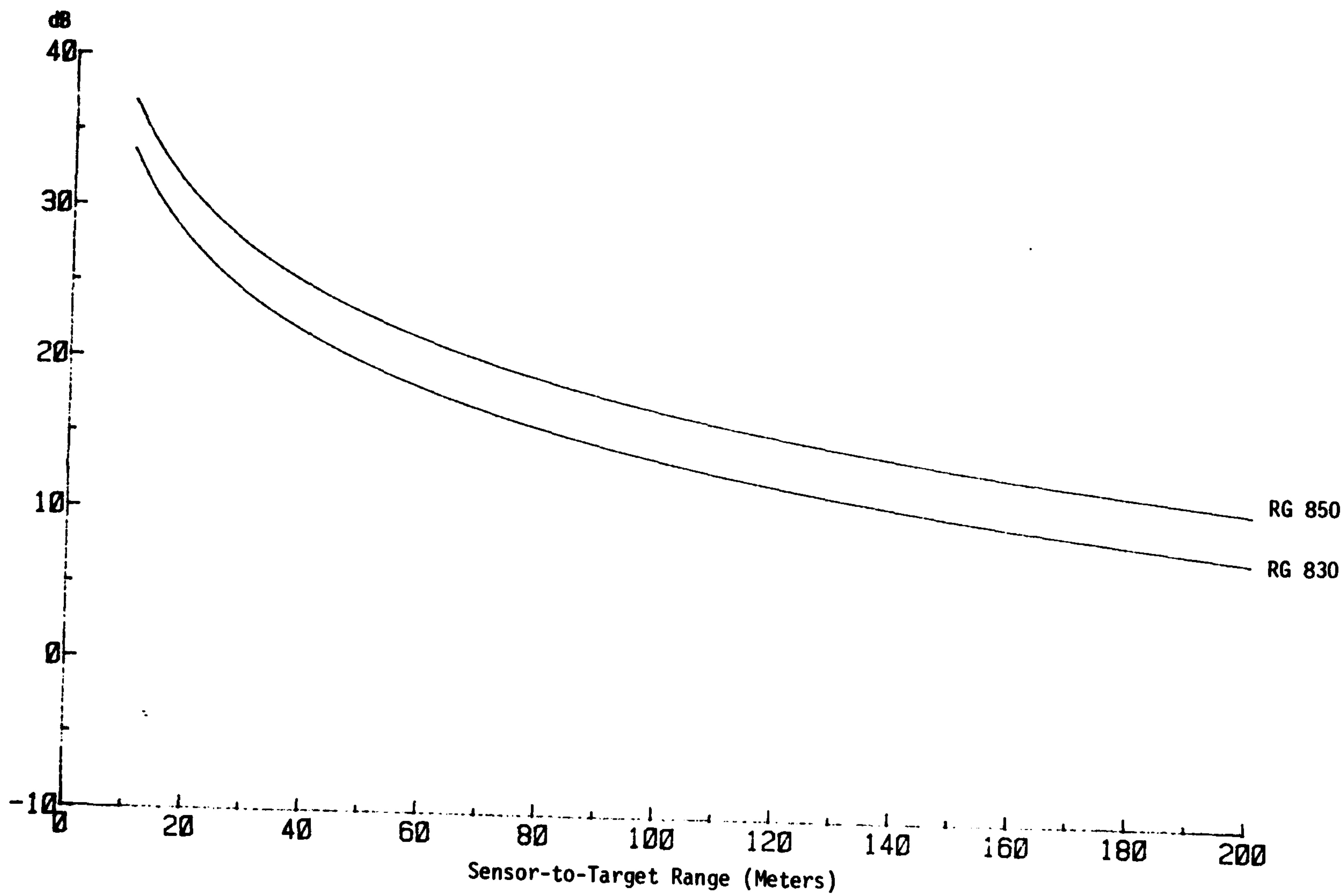

Figure A9. TV SNR Excess at the Sensor Over Eye Signal-to-Threshold at the Target for a Sensor of 300 cm^2 Area (7 inch aperture with central obstruction)

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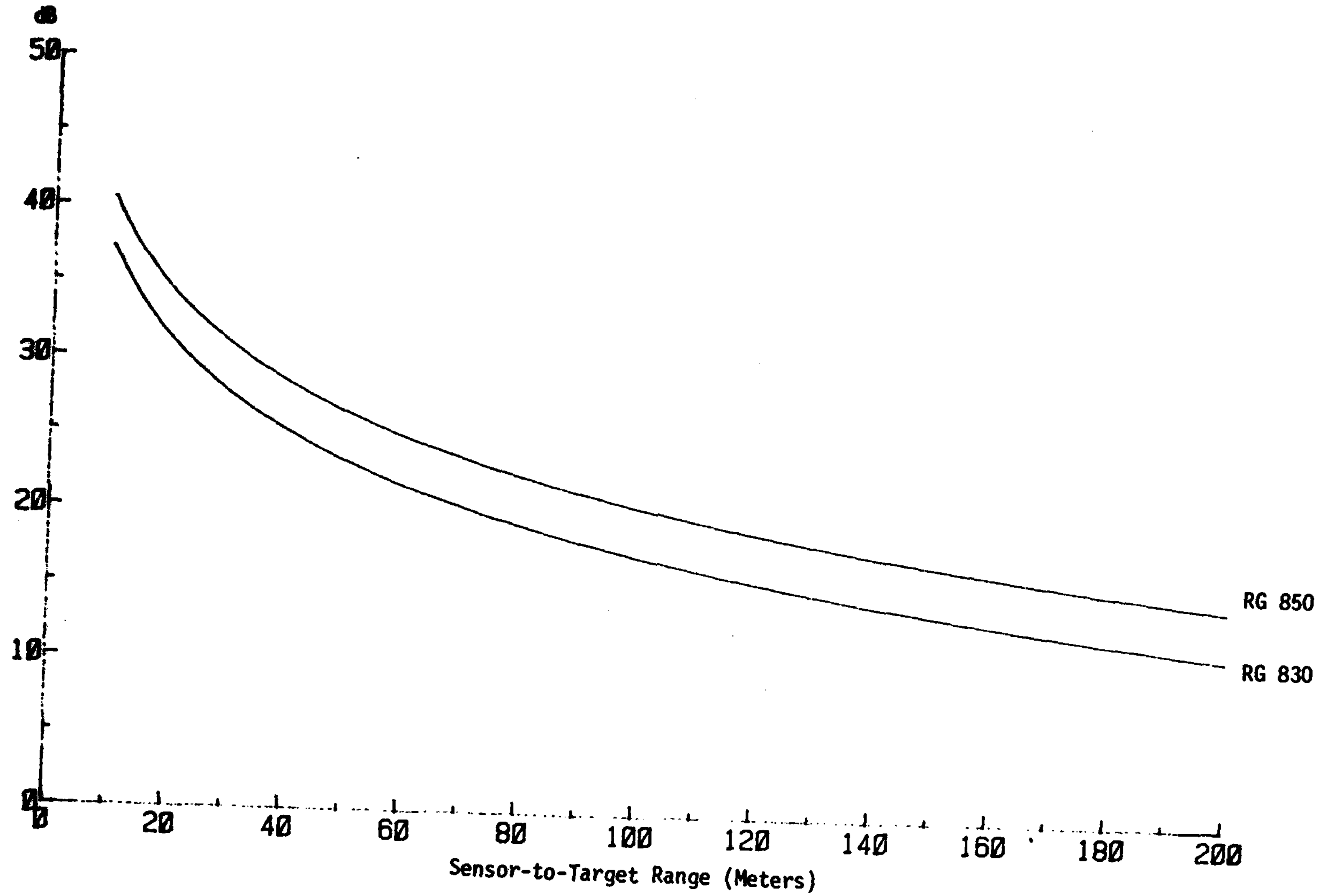

Figure A10. TV SNR Excess at the Sensor Over Eye Signal-to-Threshold at the Target for a Sensor of 675 cm^2 Area (11 inch aperture with central obstruction)

S-147-85

A.5 DISCUSSION

The eye response to wavelengths beyond 800 nanometers is non-negligible when the R^2 advantage apparent from an examination of Equations (9) and (11) is considered. Varying the illuminator distance independently of the sensor distance has no effect on the problem, since the illuminator to target distance disappears in the ratio of Equations (9) to (10).

The XYBION camera has a decreasing quantum efficiency with wavelength because of the effort XYBION has made to obtain a flat response in the responsivity units of Figure A4. The quantum efficiency can be calculated from the responsivity:

$$\eta = \frac{R_i}{0.808\lambda} , \qquad (12)$$

where R_i is in amperes per watt and λ is in micrometers. Photocathodes exist with η in excess of 0.1 at 800 nanometers, while the XYBION has $\eta < 0.05$ at this wavelength.

The only complete solution to the problem while using the current SB-100 illuminators is to increase the aperture area to at least 675 cm^2 while maintaining the minimum illuminator intensity necessary for an acceptable TV SNR.

The only solution which does not require illumination level adjustment is to use a different illuminator and sensor which operate outside the eye's spectral response. A 1.06 μm laser illuminator and an S-1 intensifier response is an example of such a system.

APPENDIX A
REFERENCES

1. Griffin, D. R., R. Hubbard and G. Wald, "The Sensitivity of the Human Eye to Infra-Red Radiation", JOSA, Vol. 37, No. 7, pp. 546-554 (July 1947).

2. SB-100 High Intensity Searchlight with Schott RG 830 IR Filter, sold by Fairington Technologies, Inc.

3. Dereniak, E. L. and D. G. Crowe, Optical Radiation Detectors, Chap. 5, Wiley (1984).

4. Handbook of Optics, Fig. 32, Chap. 32, McGraw-Hill (1978).

5. Ealing Optics Catalog, p. 183 (1984/85).

6. Laser Focus Buyer's Guide, p. 451 (1983).

APPENDIX B

ALTITUDE-AZIMUTH MOUNT DRAWINGS

PARTS LIST

Job #0005 UA Azimuth/Altitude Head

Part #	Qty.	Name	Supplier	P/N
0001	1	Shaft, Main Lower		
0002	1	Plate, Bottom		
0003	1	Shaft, Main Upper		
0004	1	Plate, Mount		
0005	1	Plate, Lockdown Cover		
0006	2	Hub, Lockdown		
0007	1	Gear, Azimuth	Browing P/N BWG24100-1 3/8bore	
0008	1	Gear, Altitude	Browing P/N BWG24100-1 3/8bore	
0009	2	Bearing, Main	17mm ID x 40mm OD x 12mm L	
0010	1	Housing, Main		
0011	2	Gear, Worm	Boston GLUH 12924	
0012	1	Shaft, Mount Driver		
0013	1	Shaft, Mount Floating		
0014	2	Housing, Worm		
0015	2	Switch, Altitude Stop	Micro Switch	
0016	2	Bearing, Large	Berg P/N B7-42	
0017	4	Bearing, Worm		
0018	2	Shaft, Worm		
0019	2	Bearing, Small	Berg P/N B7-41	
0020	2	Plate, Motor Mount		
0021	1	Housing, Altitude		
0022	1	Plate, Altitude Housing Cover		
0023	2	Motor	Portascap P/N B 216E	
0024	2	Gearbox	Portascap P/N B-24	
0025	1	Support, Mount Plate		

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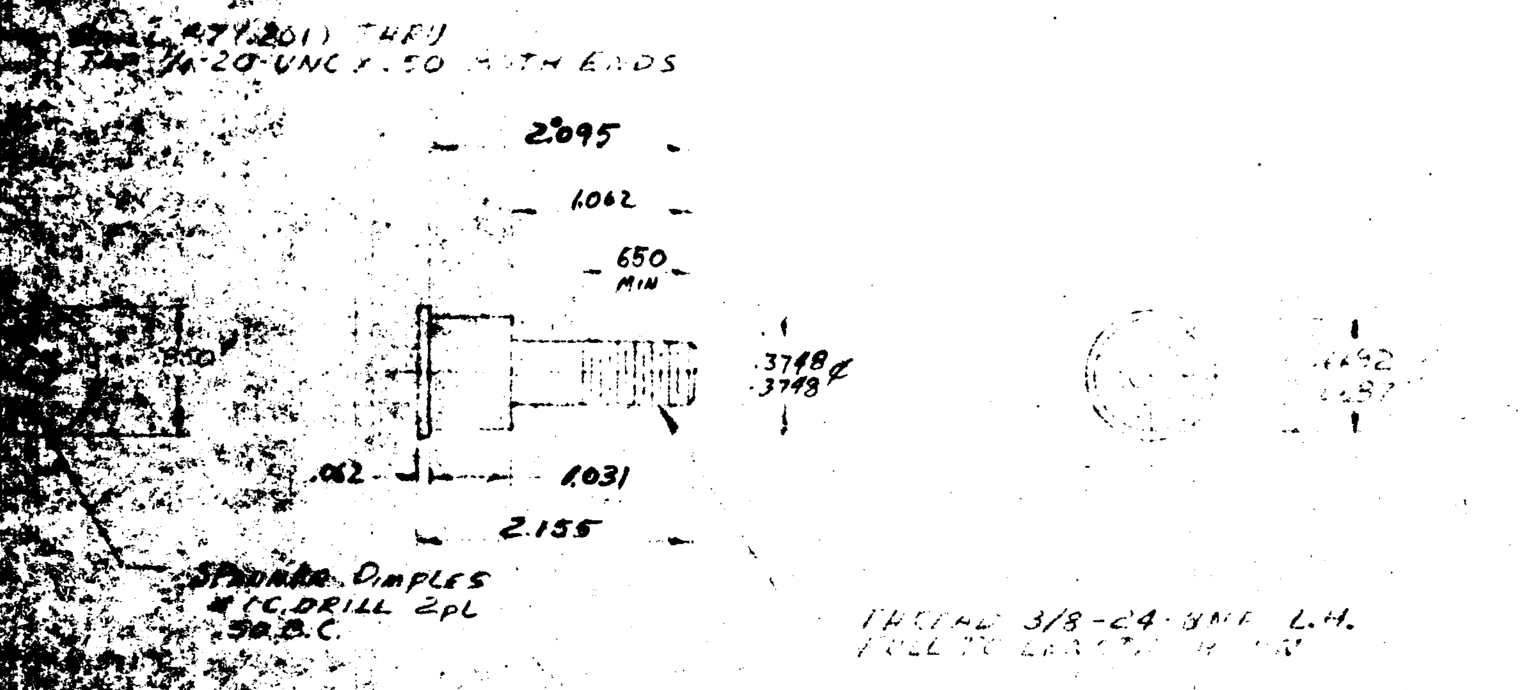

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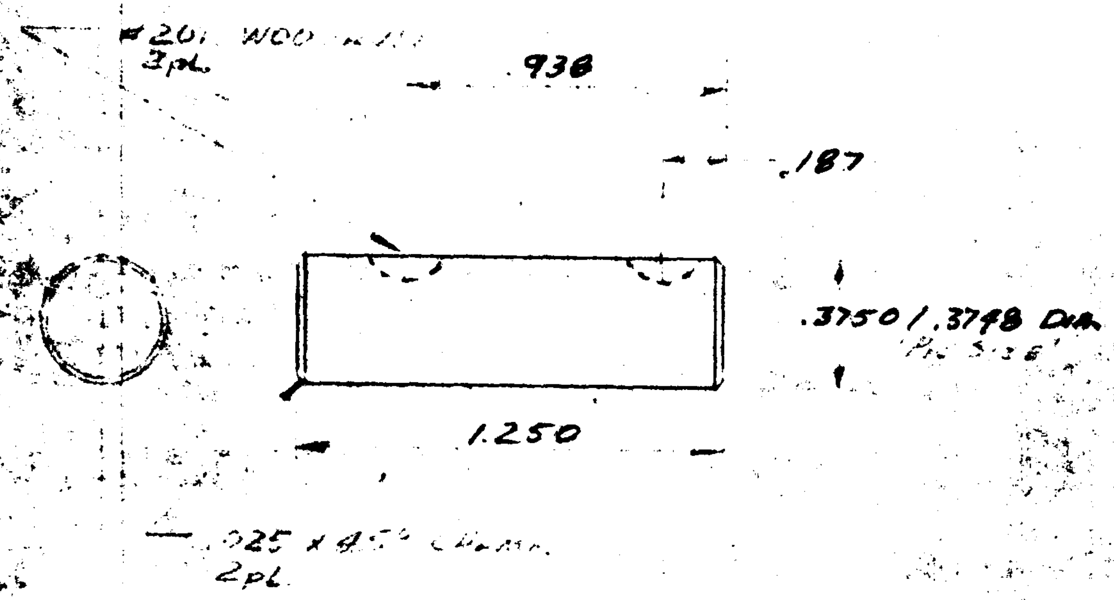

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SHAFT, MOUNT DRIVER

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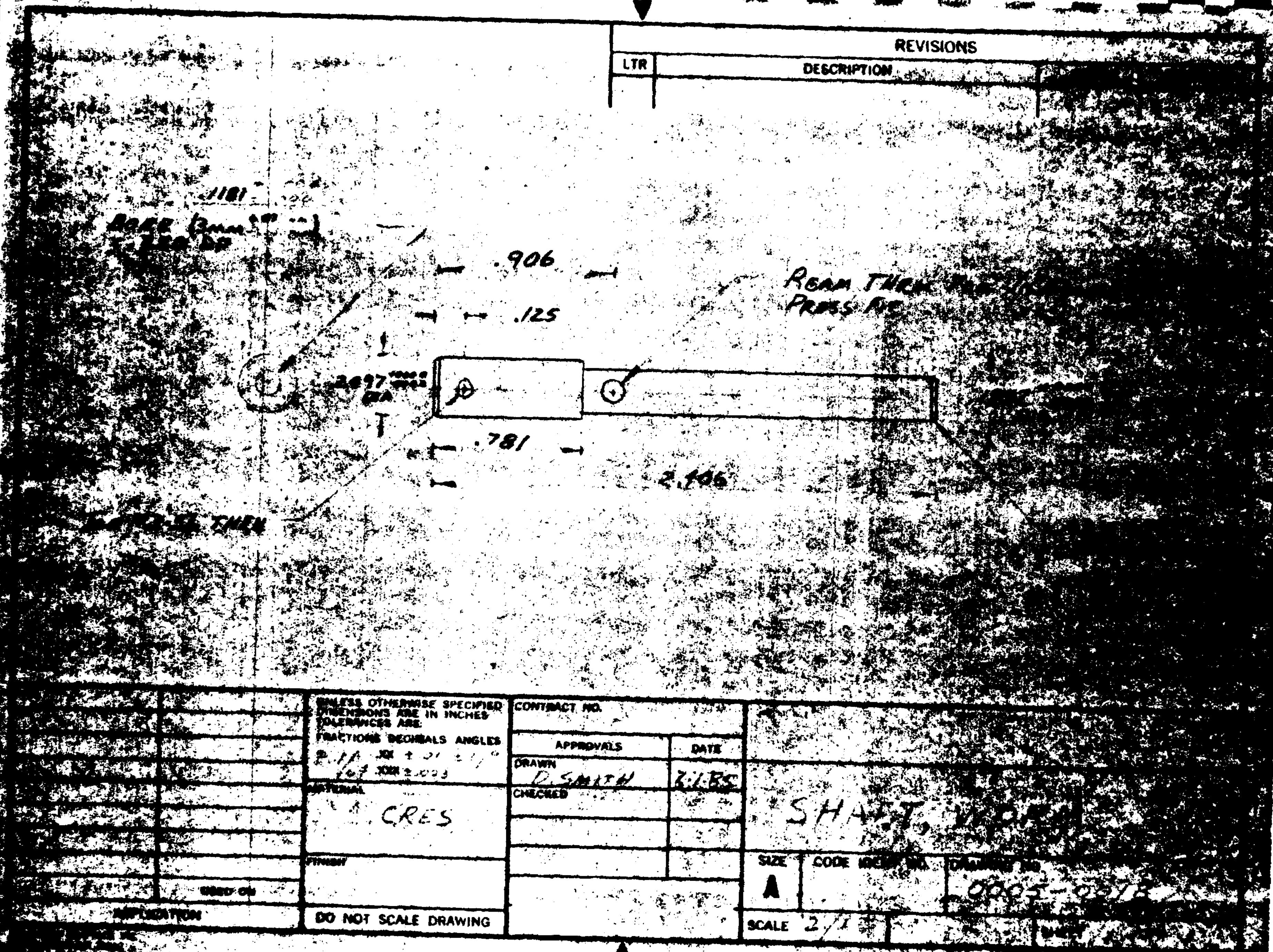
APPLICATION

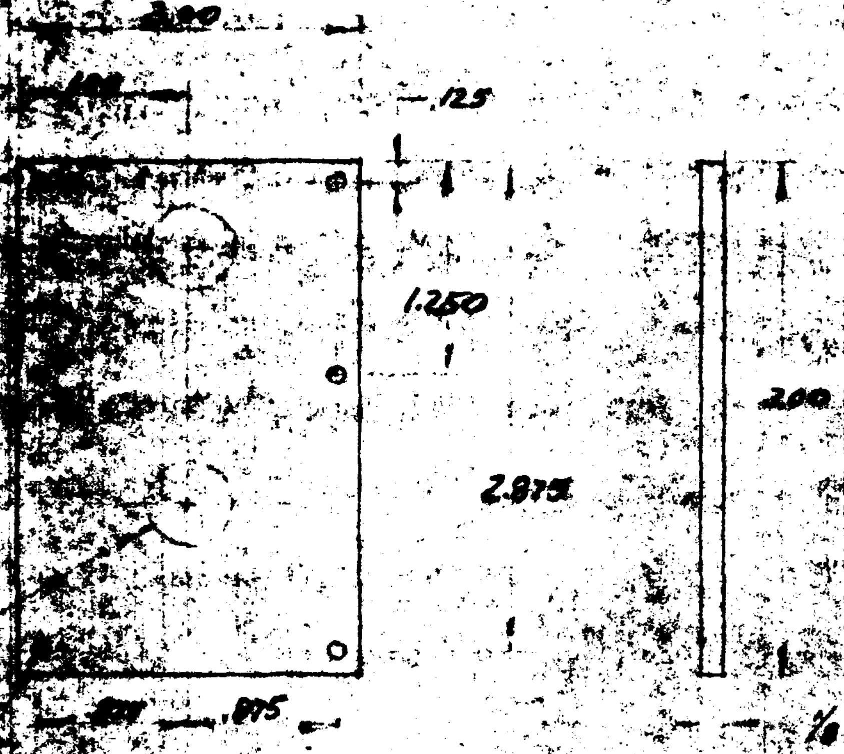
DO NOT SCALE DRAWING


REVISIONS
LTR
DESCRIPTION
.1181
.906
.125
REAM THRU
PRESS FIT
.781
2.406
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
MATERIAL
CRES
FINISH
DO NOT SCALE DRAWING
USED ON
APPLICATION
CONTRACT NO.
APPROVALS
DATE
DRAWN
D. SMITH
CHECKED
SHAFT,
SIZE
A
CODE IDENT NO.
DRAWING NO.
SCALE 2/1

DWG. NO.

REVISIONS

REV	DESCRIPTION



QTY REQD	FSCM NO	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
1/64 .XX .XXX

CONTRACT NO

APPROVALS	DATE
DRAWN	
CHECKED	
ISSUED	

MATERIAL
ALUM

FINISH
BLK ANODIZE

USED ON

DO NOT SCALE DRAWING

PLATE
COVER

SIZE A

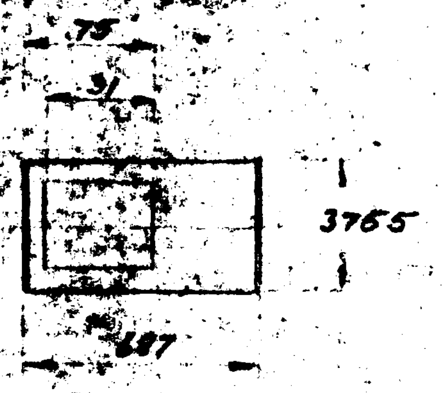
FSCM NO.

DWG NO.

SCALE Full

REVISIONS

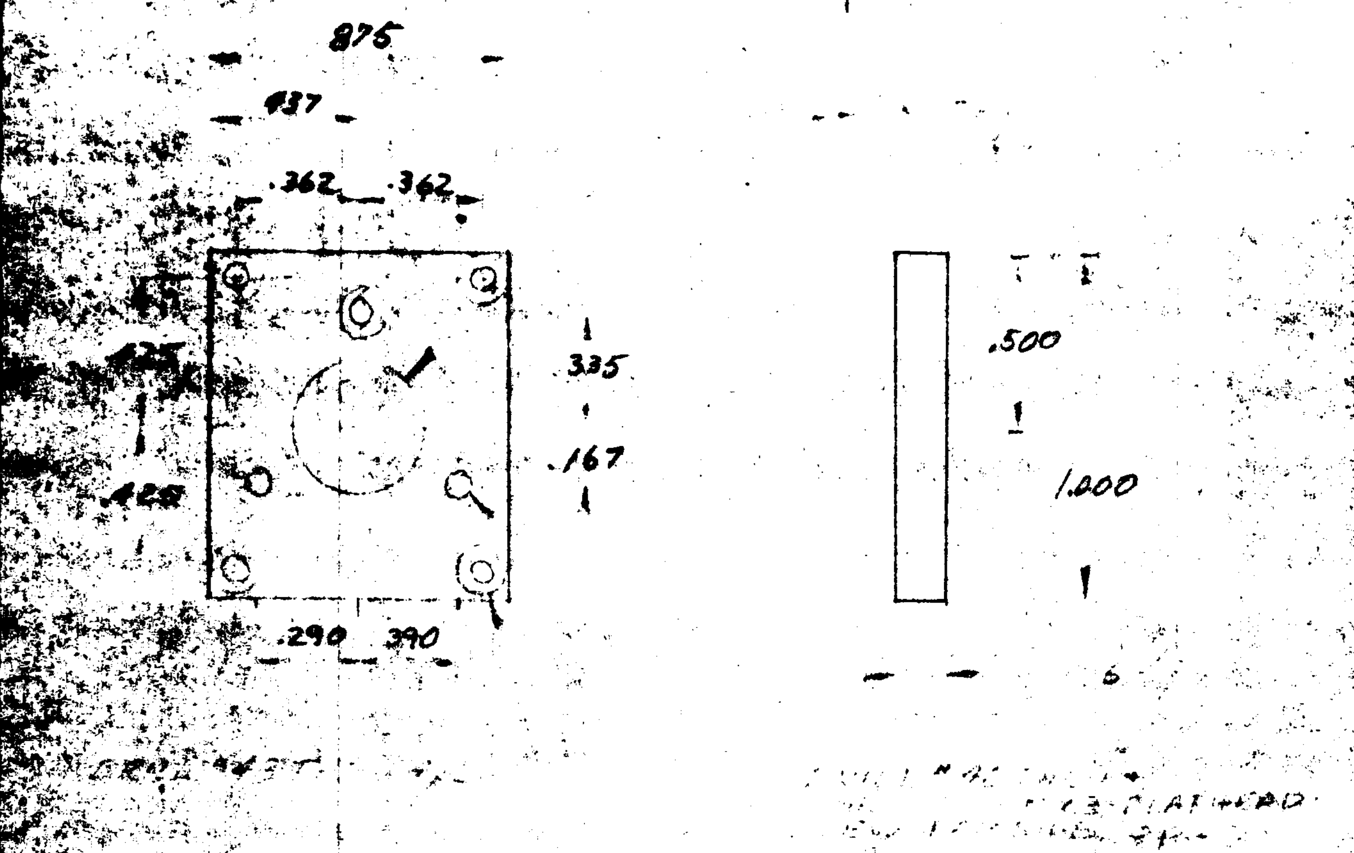
LTR	DESCRIPTION	DATE	APPROVED



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS DECIMALS ANGLES XX ±.01 .XXX ±.003	CONTRACT NO			
	APPROVALS	DATE		
	DRAWN			
MATERIAL Pic Stock 303	CHECKED		SHAFT, MOUNT FLOATING	
FINISH			SIZE A	CODE IDENT NO.	DRAWING NO.
DO NOT SCALE DRAWING			SCALE		SHEET OF

USED ON

APPLICATION



REVISIONS

LTR	DESCRIPTION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE	CONTRACT NO.
FRACTIONS DECIMALS ANGLES	APPROVALS / DATE
XX / XXX	DRAWN 6-2-85
MATERIAL	CHECKED
FINISH	
DO NOT SCALE DRAWING	

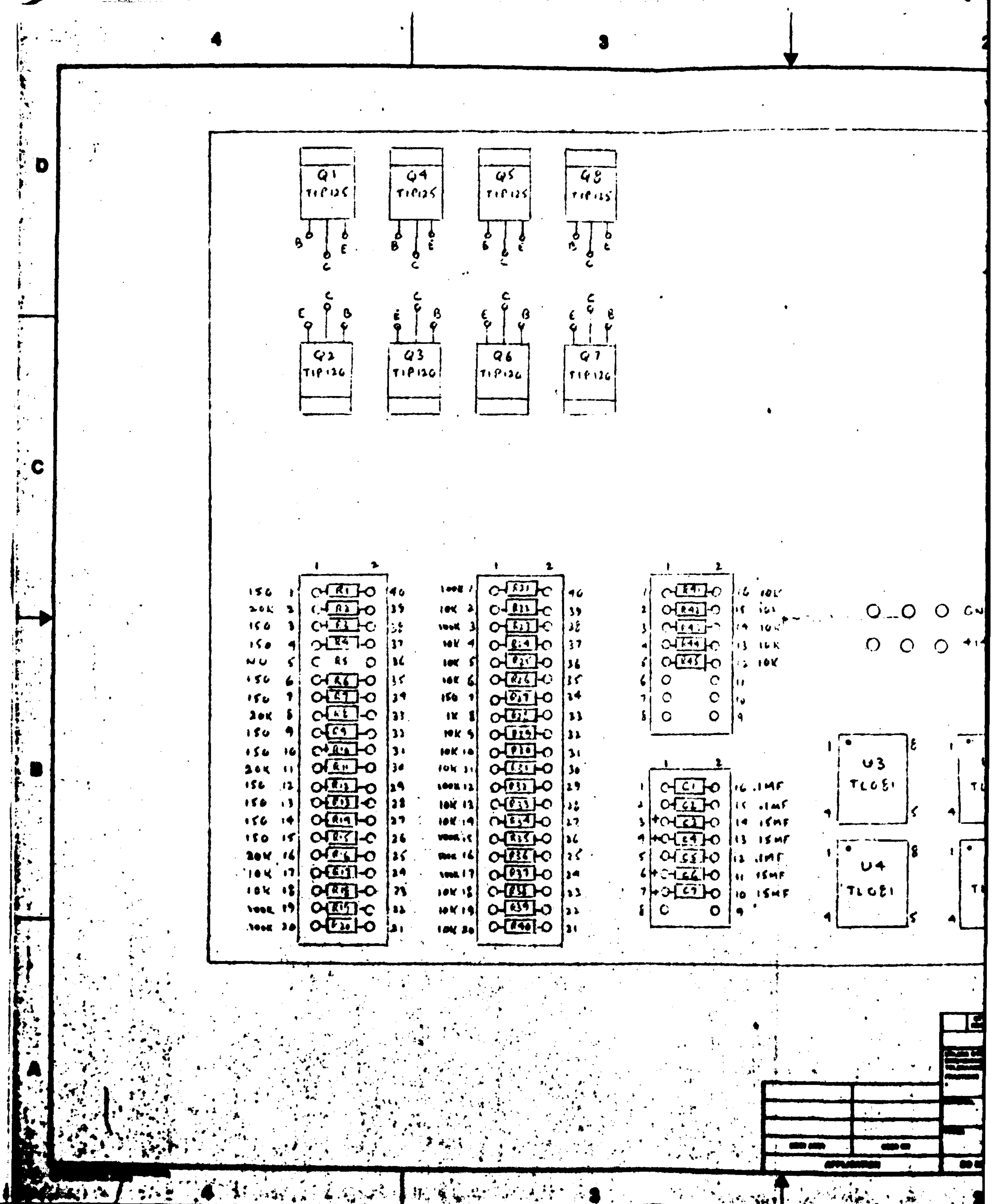
PLATE, MOTOR MOUNT

ESCAP B24

SIZE	CODE IDENT NO.	DRAWING NO.
A		0005-0020

SCALE 1/1 SHEET 1 OF 1

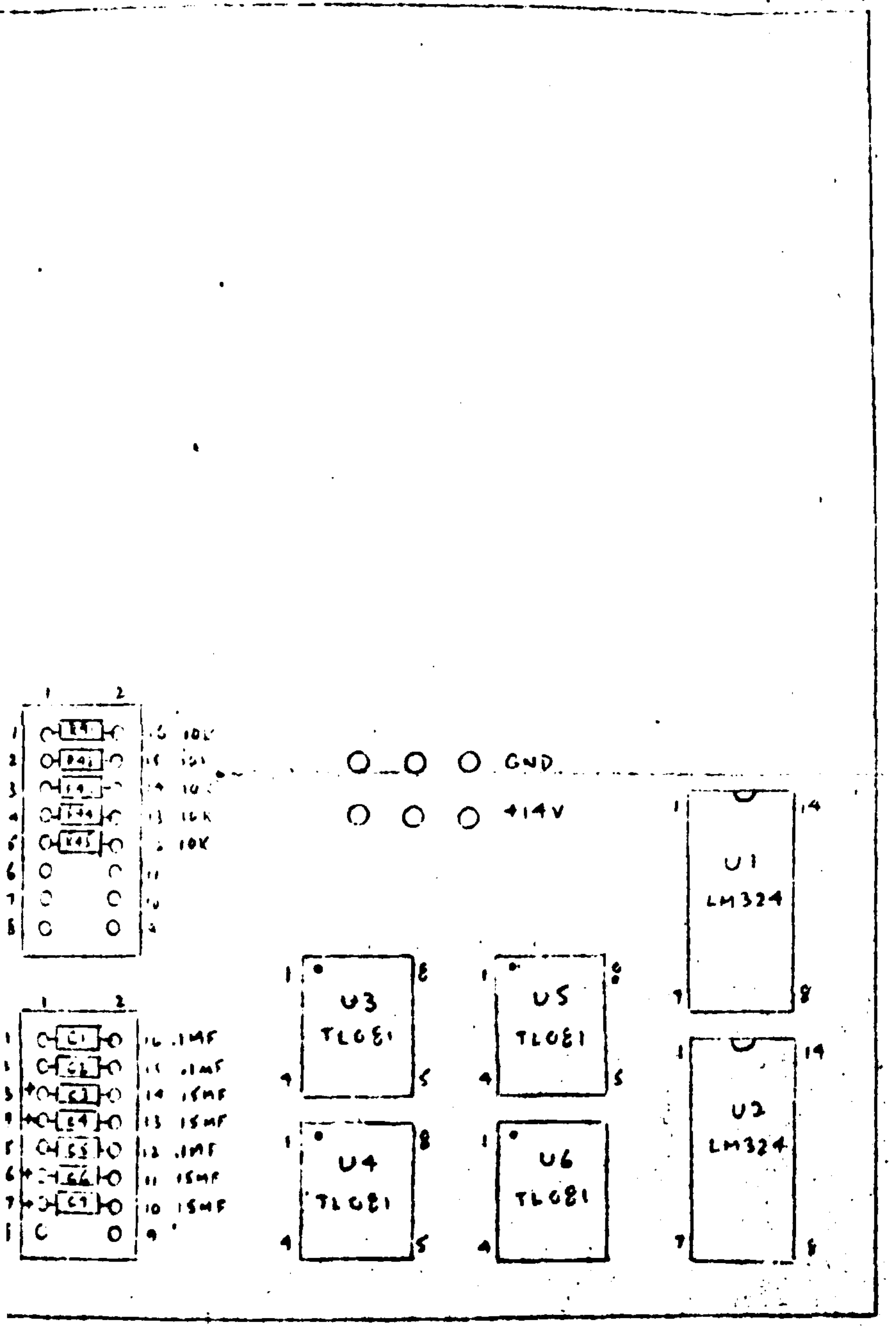
USED ON	APPLICATION



4
3
D
C
B
A
Q1
TIP125
Q4
TIP125
Q5
TIP125
Q8
TIP125
Q2
TIP126
Q3
TIP120
Q6
TIP126
Q7
TIP126
U3
TL081
U4
TL081

2 1

REVISIONS



2

PARTS LIST

DELTA TAU DATA SYSTEMS

ASSY
W.W. LOGIC BOARD
TELESCOPE POSITIONER

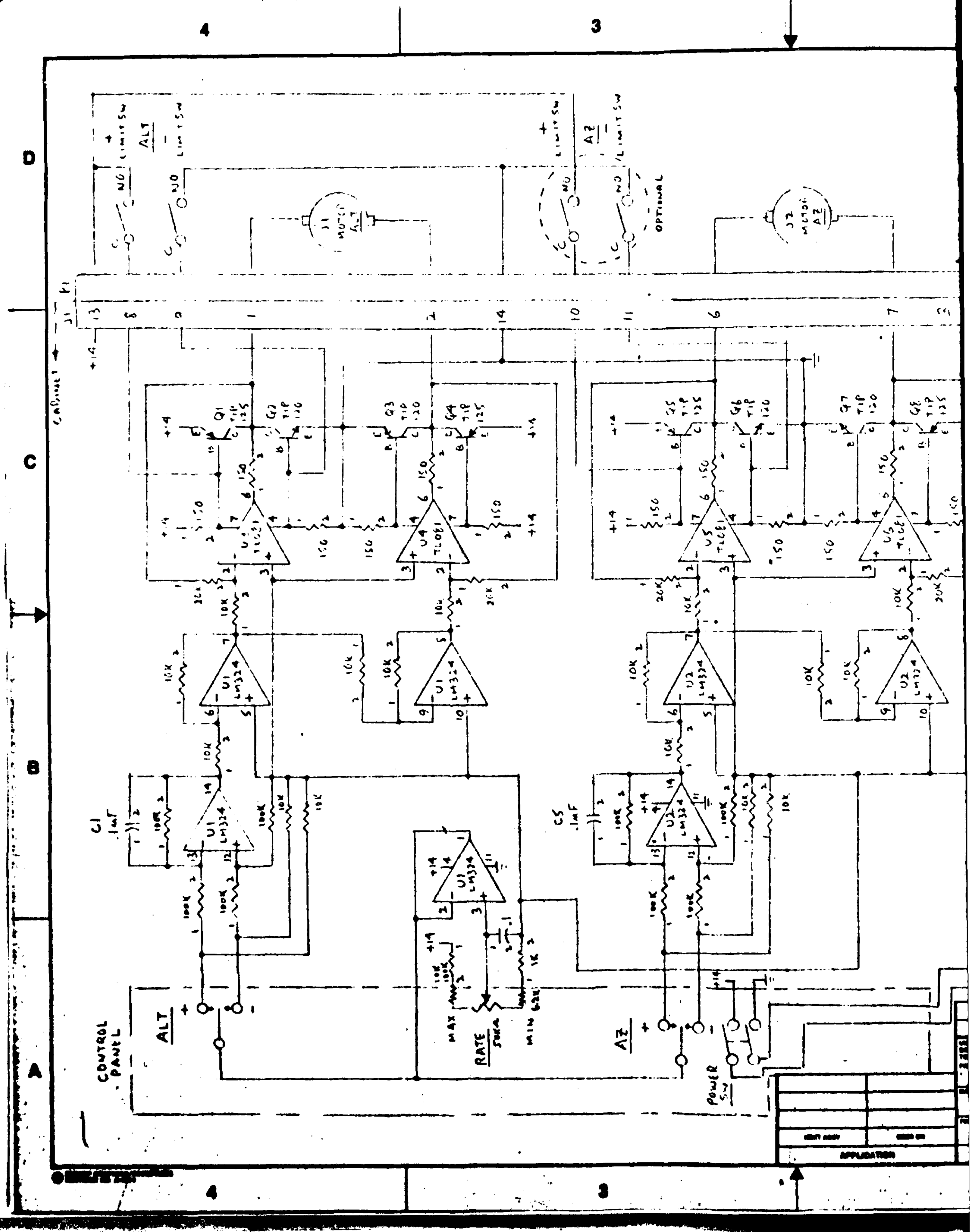
M. BOUDAL 6/7/85

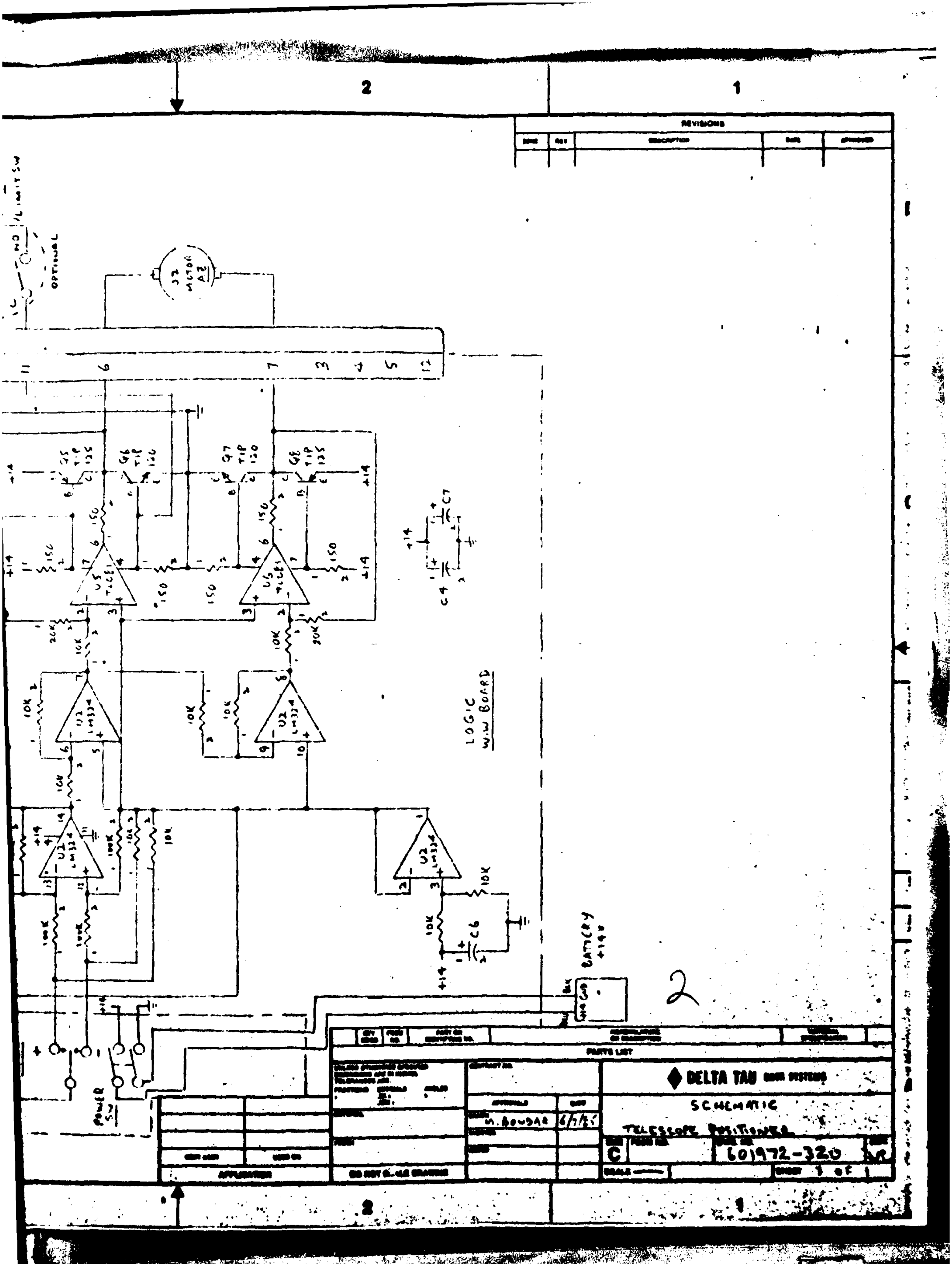
C

APPLICATION

DO NOT SCALE DRAWING

SHEET 1 of 1


4
3
D
C
B
A
+ LIMIT SW
ALT
− LIMIT SW
+ LIMIT SW
AZ
− LIMIT SW
OPTIONAL
MOTOR ALT
MOTOR AZ
CABINET
Q1 TIP 125
Q2 TIP 120
Q3 TIP 120
Q4 TIP 125
Q5 TIP 125
Q6 TIP 120
Q7 TIP 120
Q8 TIP 125
U3 TL081
U4 TL081
U5 TL081
U6 TL081
U1 LM324
U2 LM324
C1 .1MF
C5 .1MF
ALT
AZ
RATE 5K
MAX
MIN
POWER SW
CONTROL PANEL
APPLICATION



PARTS LIST

DELTA TAU

SCHEMATIC

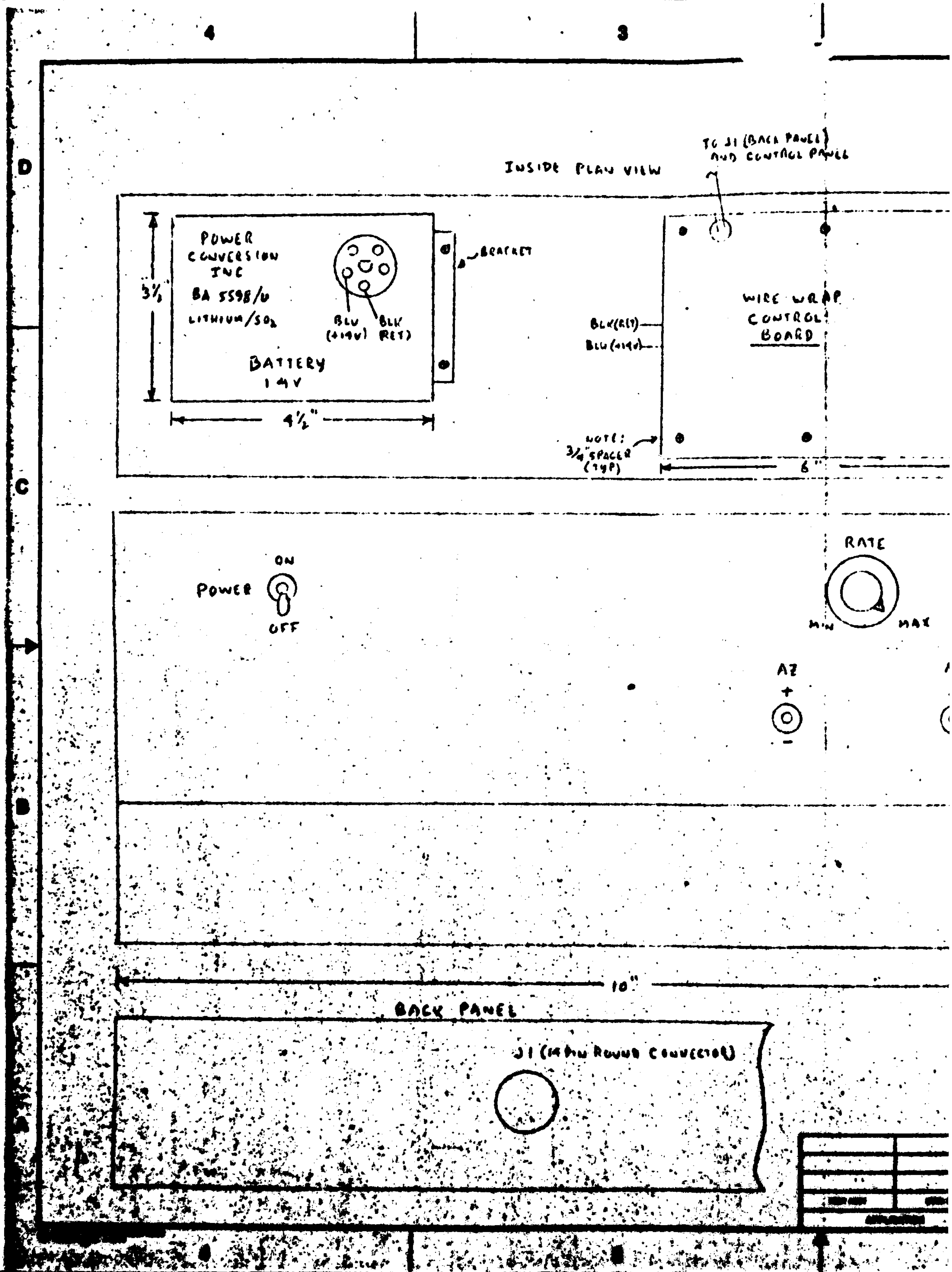
TELESCOPE POSITIONER

M. BONDAR 6/7/85

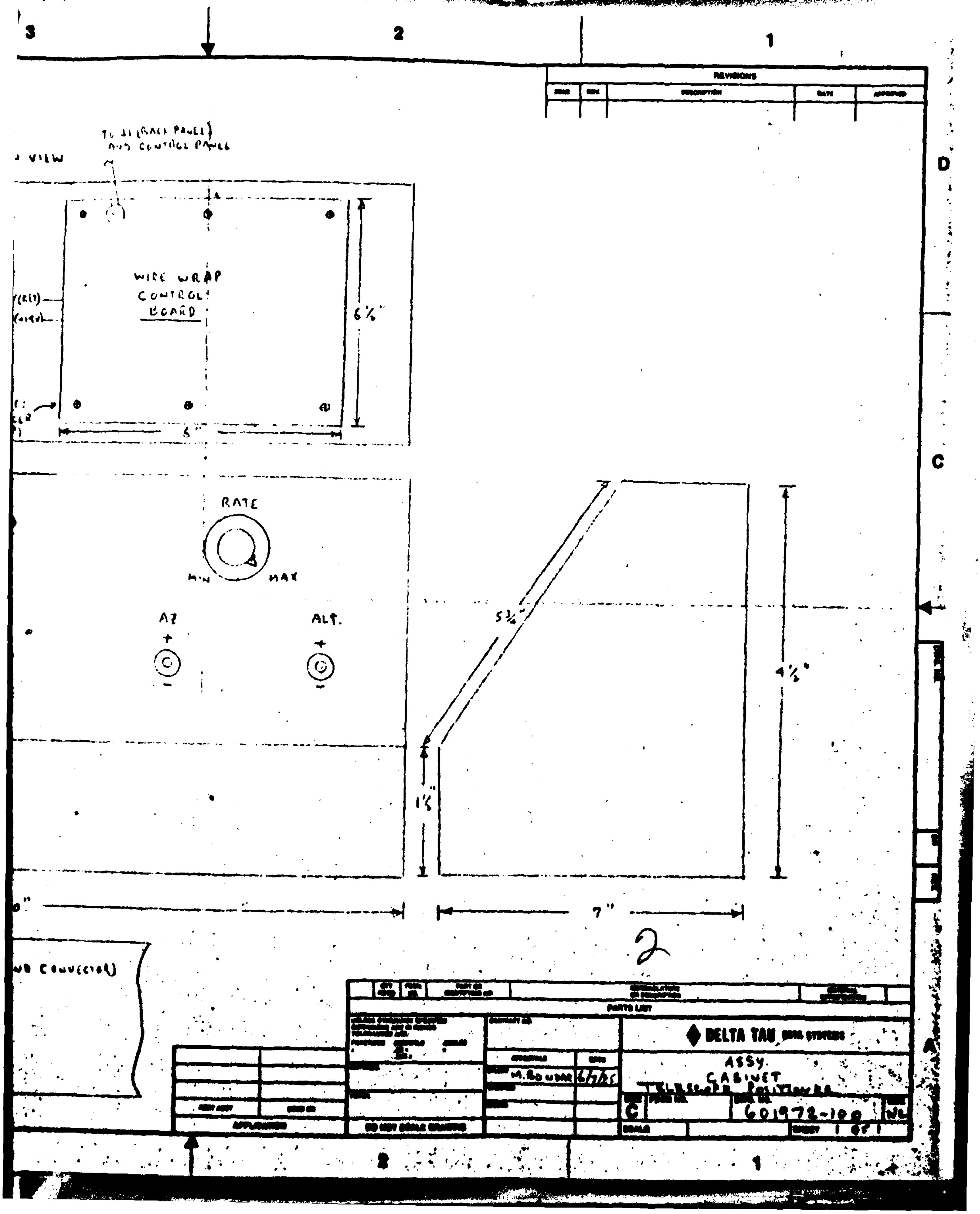
C

60972-320

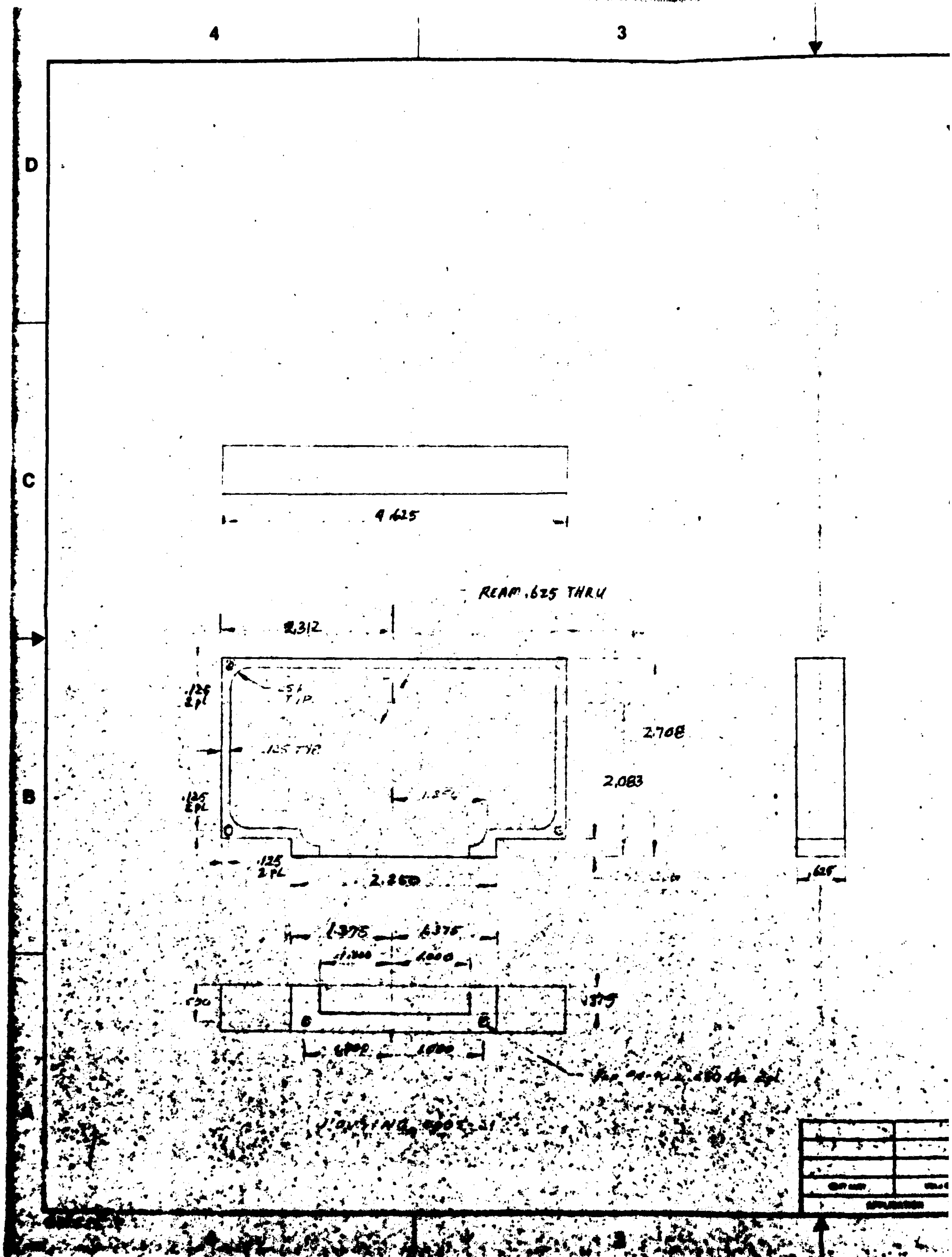
SHEET 1 OF 1



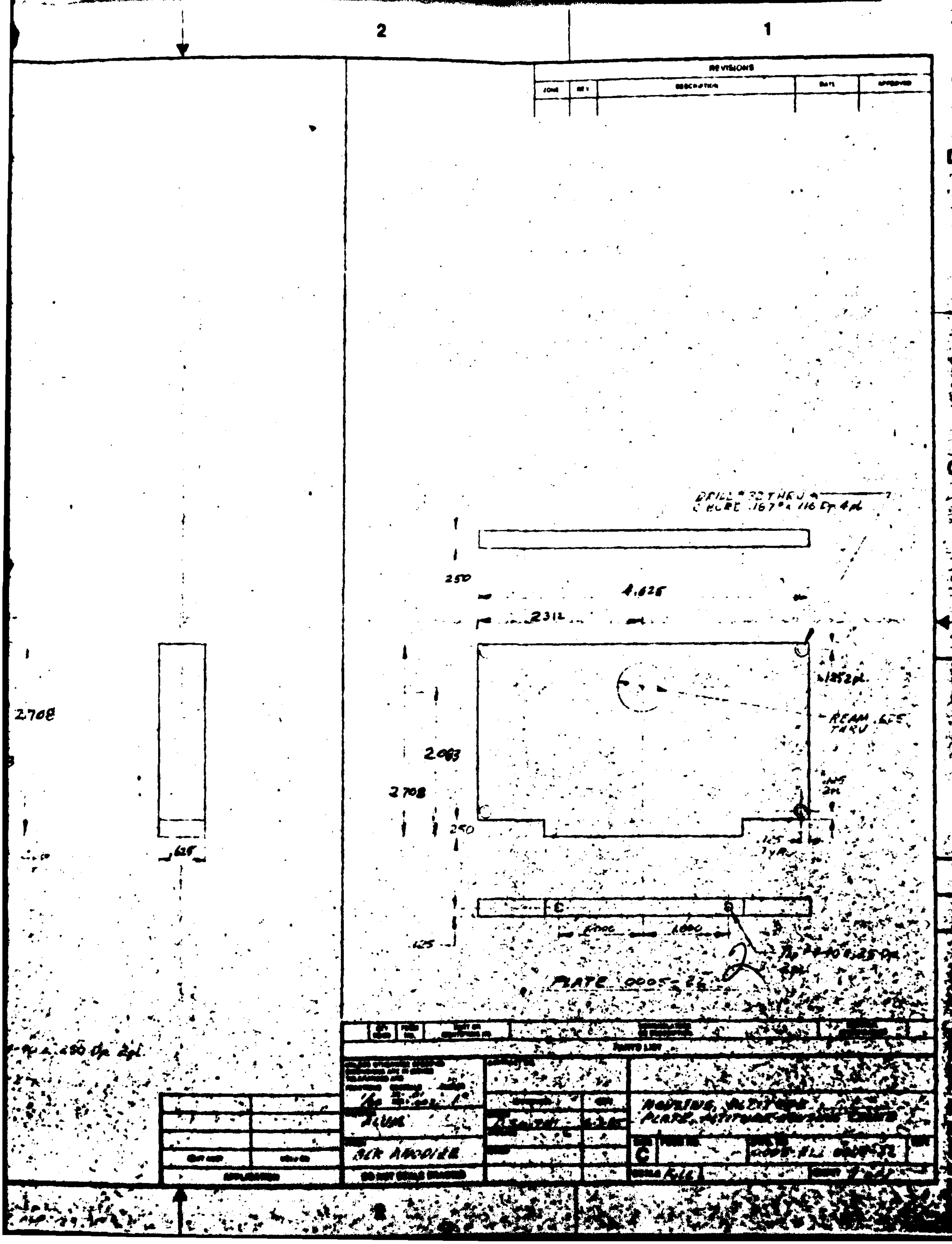
4
3
D
C
B
INSIDE PLAN VIEW
TO J1 (BACK PANEL) AND CONTROL PANEL
POWER CONVERSION INC
BA 5598/U
LITHIUM/SO2
BLU (+14V)
BLK RET)
BATTERY 14V
BRACKET
3 1/2"
4 1/2"
WIRE WRAP CONTROL BOARD
BLK(RET)
BLU(+14V)
NOTE: 3/4" SPACER (TYP)
6"
POWER
ON
OFF
RATE
MIN
MAX
AZ
+
-
10"
BACK PANEL
J1 (14 PIN ROUND CONNECTOR)

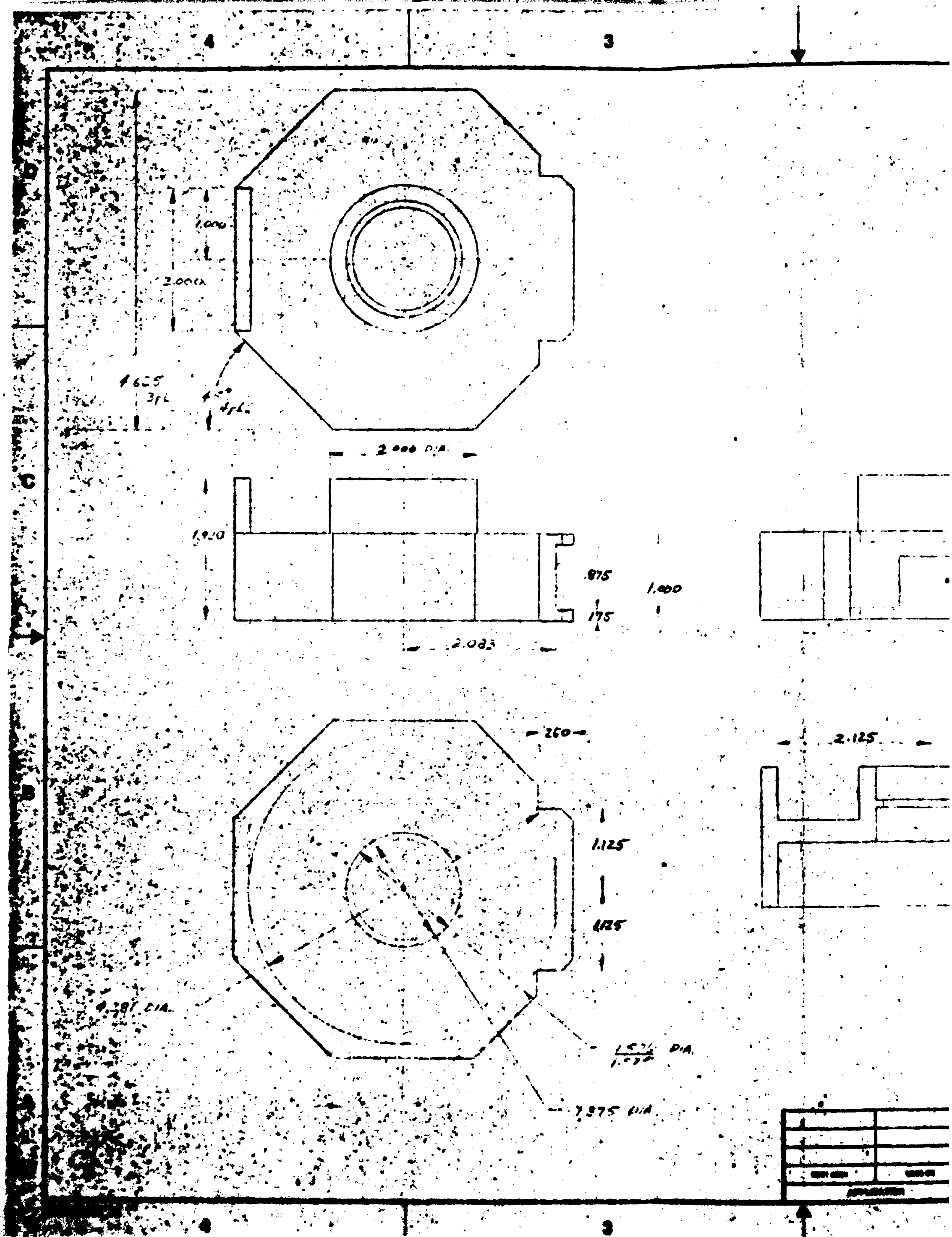


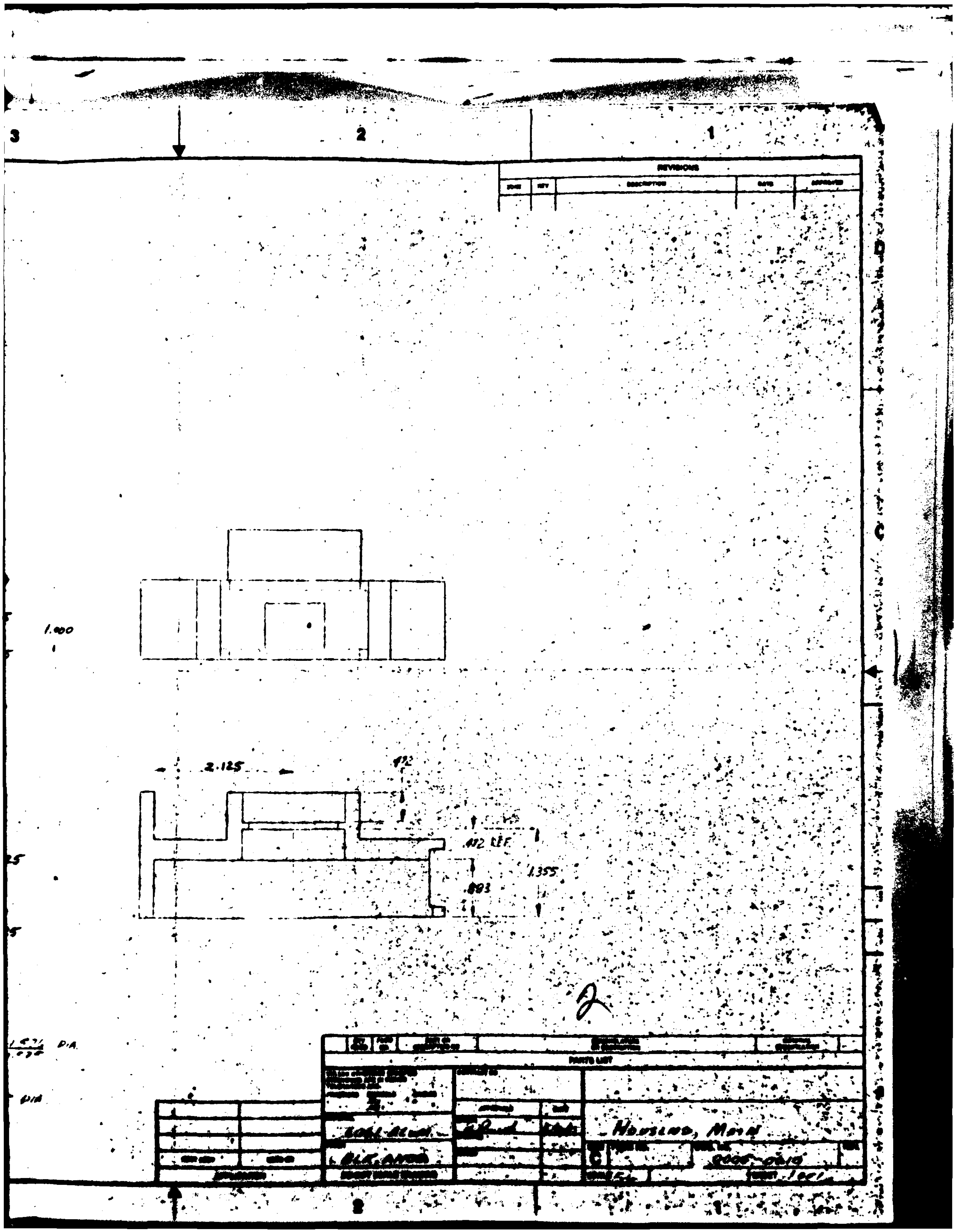
3
2
1
REVISIONS
D
C
A
TO J1 (BACK PANEL) AND CONTROL PANEL
VIEW
WIRE WRAP CONTROL BOARD
6 1/2"
6"
RATE
MIN
MAX
AZ
ALT.
5 3/4"
4 1/2"
1 1/4"
7"
2
CONNECTOR)
PARTS LIST
DELTA TAU DATA SYSTEMS
ASSY. CABINET TELESCOPE POSITIONER
M. BONDAR 6/7/85
C
601972-100
SHEET 1 OF 1
APPLICATION
DO NOT SCALE DRAWING

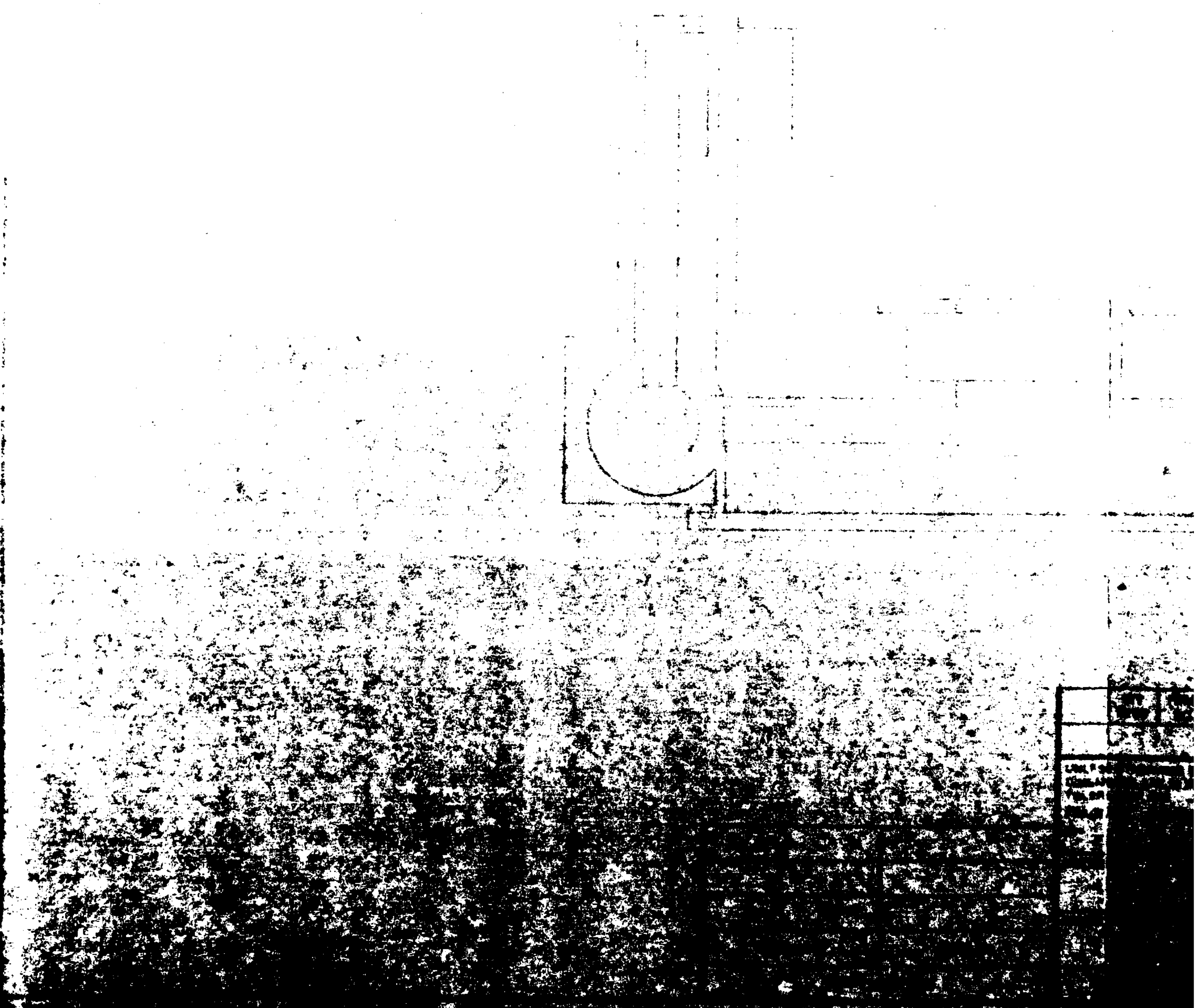


4
3
D
C
B
A
4.625
REAM .625 THRU
2.312
2.708
2.083
.125 TYP
.125 2 PL
2.250
1.375
1.375
1.000
1.000
.625

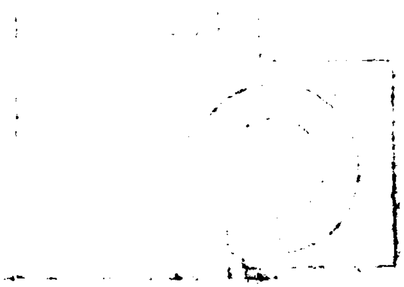

2
1
REVISIONS
2.708
.625
4.625
2.312
2.083
2.708
.250
.250
.125
PLATE 0005-2


4
3
1.000
4.625
2.000 DIA.
1.920
.875
1.000
.175
2.083
.250
2.125
1.125
1.125
DIA.
DIA.
DIA.


3
2
1
REVISIONS
1.000
2.125
.412 REF
1.355
.893
D.A.
PARTS LIST
Housing, Main



REVISIONS			
		DATE	APPROVED

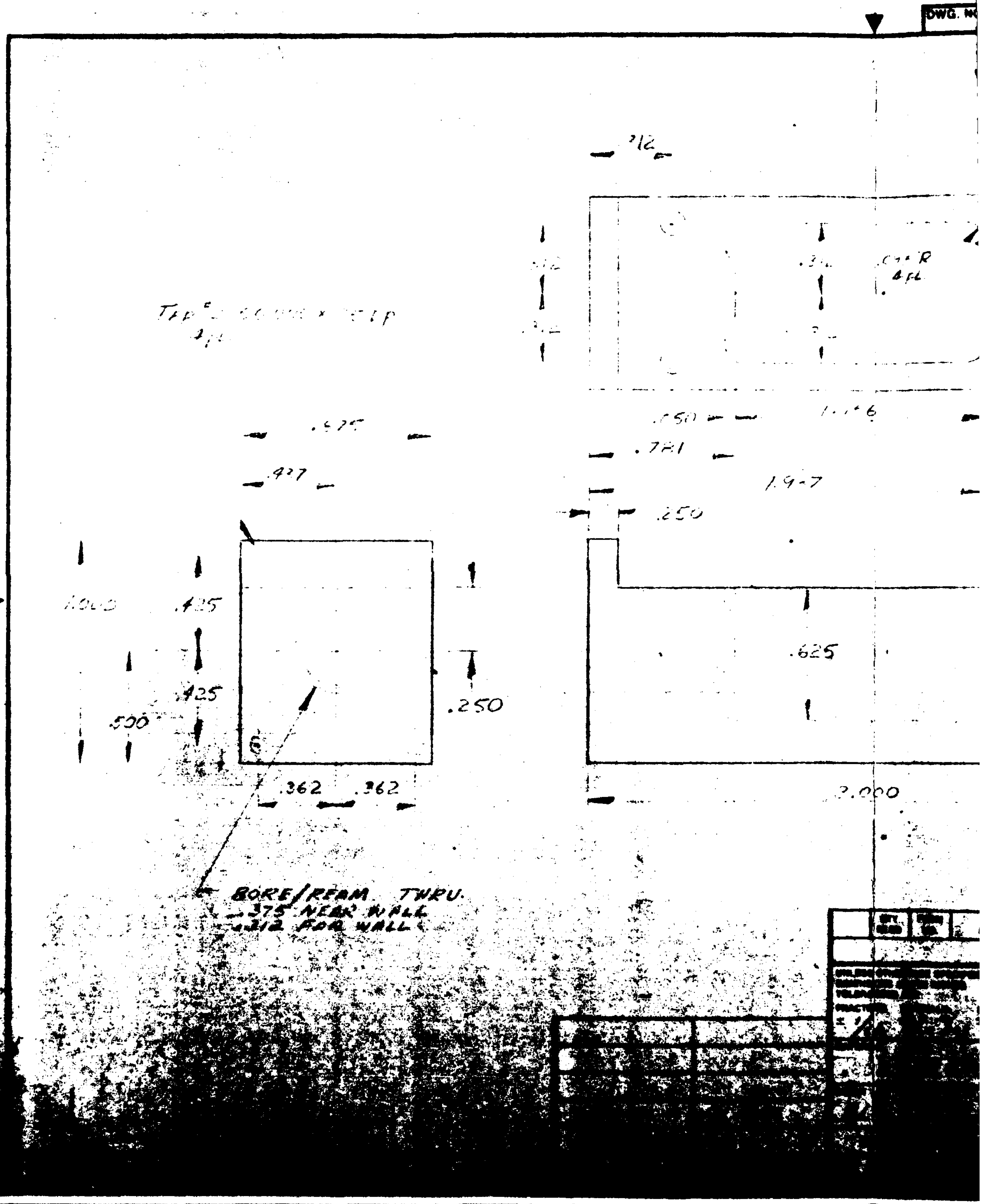


	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

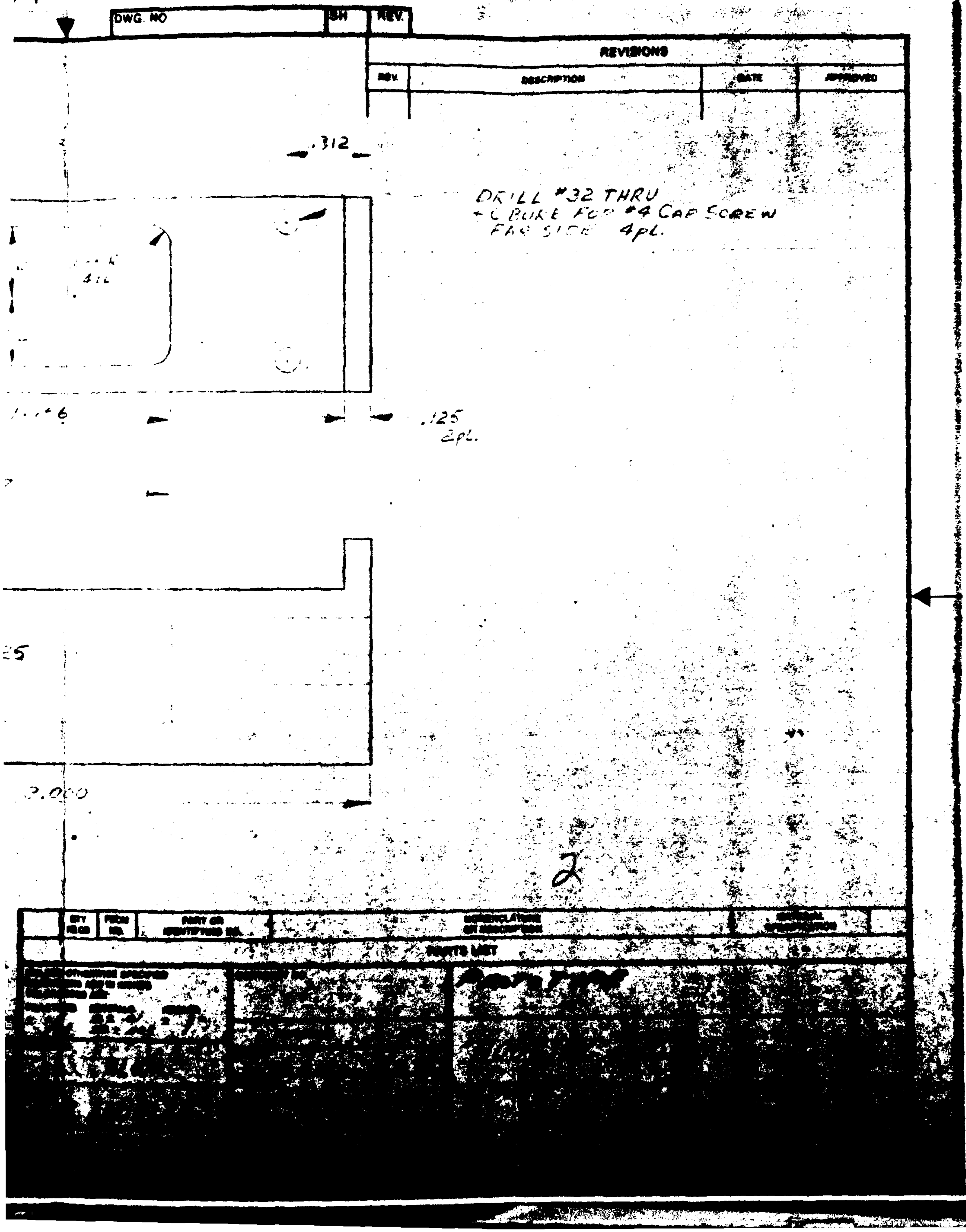
PARTS LIST

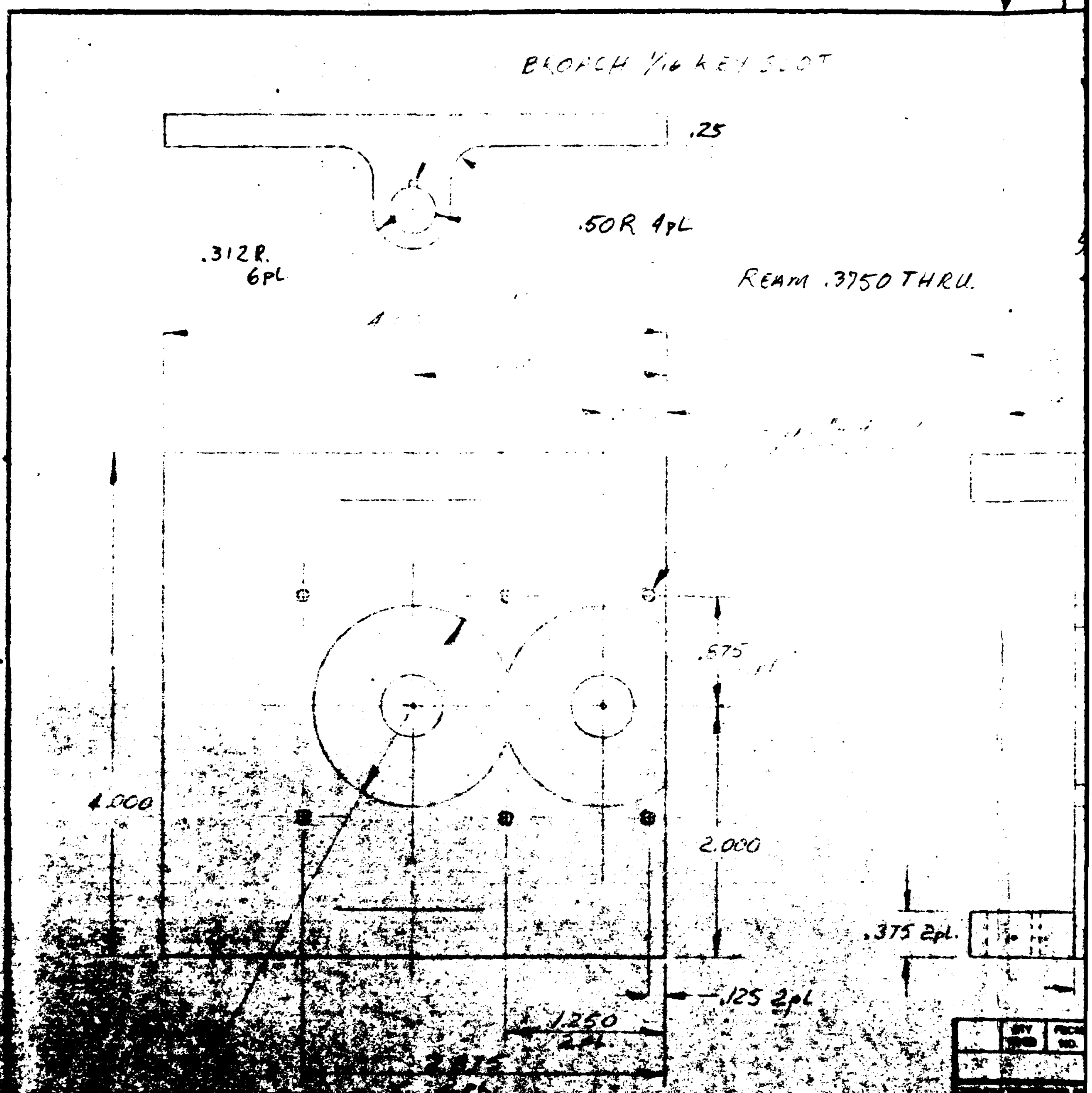
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE
DECIMALS

CONTRACT NO.



DWG. NO
.427
.425
.425
.500
.250
.362
.362
.781
.250
.625
2.000
BORE/REAM THRU.
.375 NEAR WALL
.312 FAR WALL

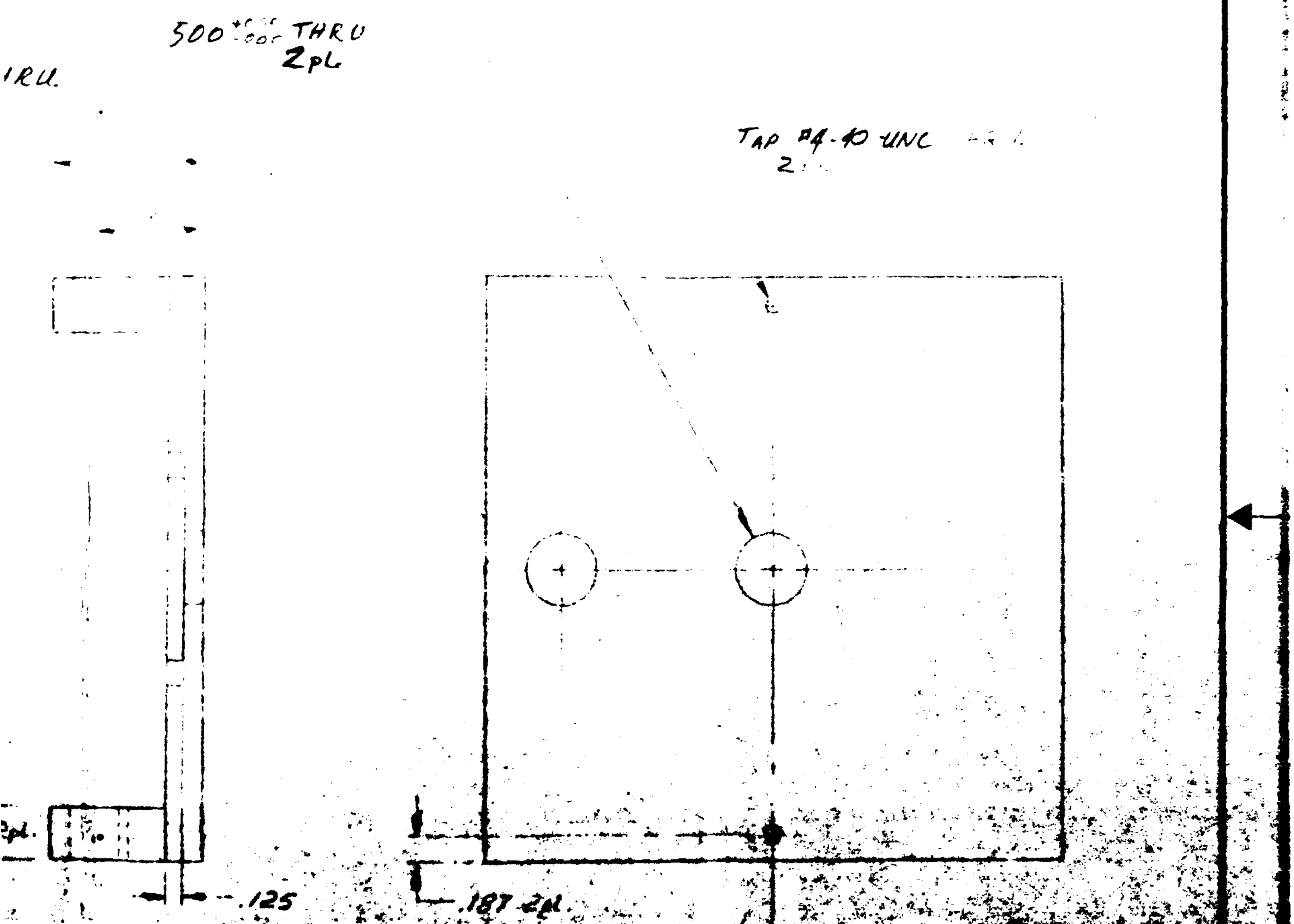

DWG. NO
SH
REV.
REVISIONS
REV.
DESCRIPTION
DATE
APPROVED
.312
DRILL #32 THRU
+ C BORE FOR #4 CAP SCREW
FAR SIDE 4pL.
.125
2pL.
2.000
2
QTY REQD
ITEM NO.
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
PARTS LIST


BROACH 1/16 KEY SLOT
.25
.50R 4pL
.312R.
6pL
REAM .3750 THRU.
.875
4.000
2.000
.375 2pL.
.125 2pL
1.250
2PL
2.875
2PL

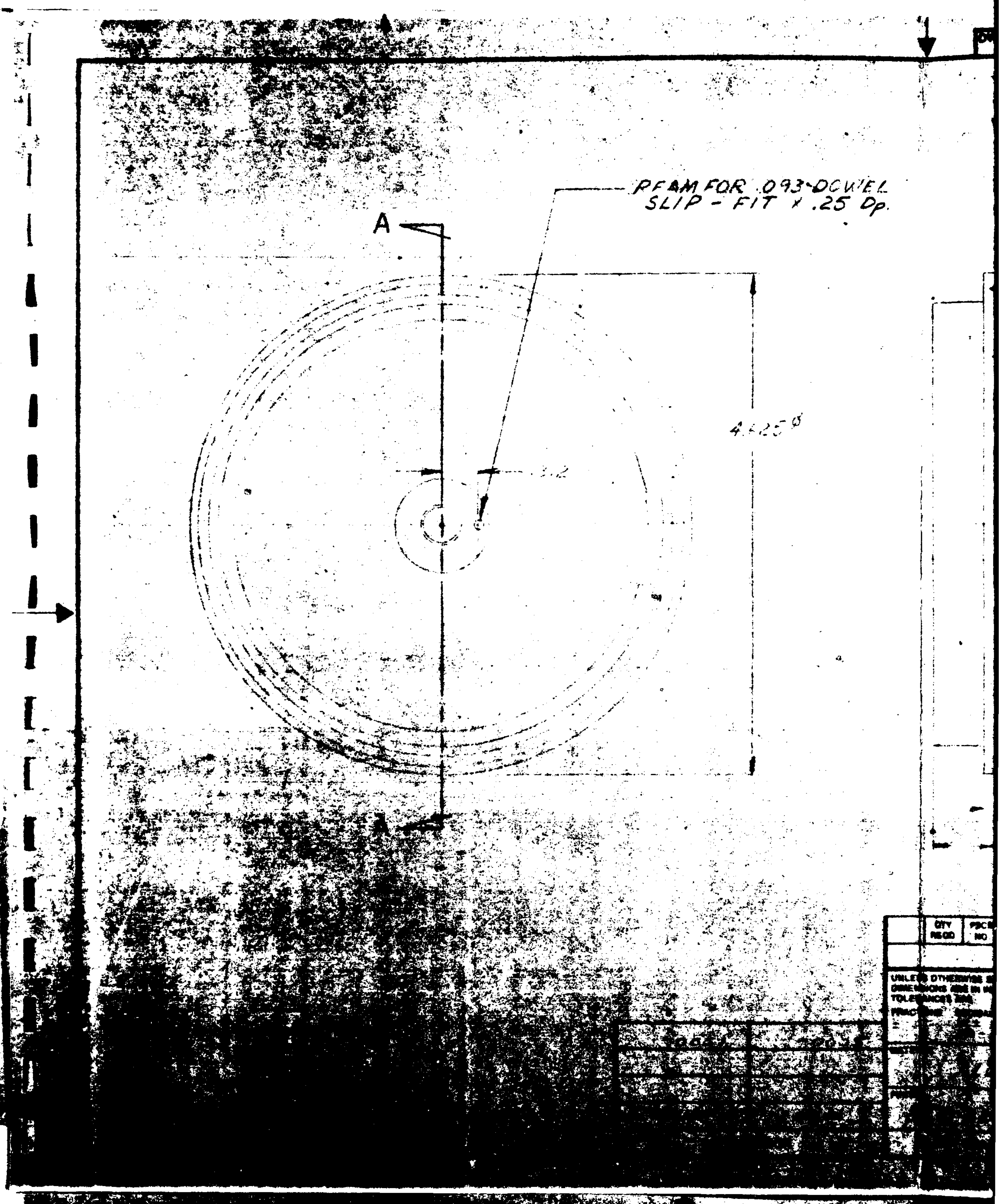
DWG NO	SH	REV

REVISIONS

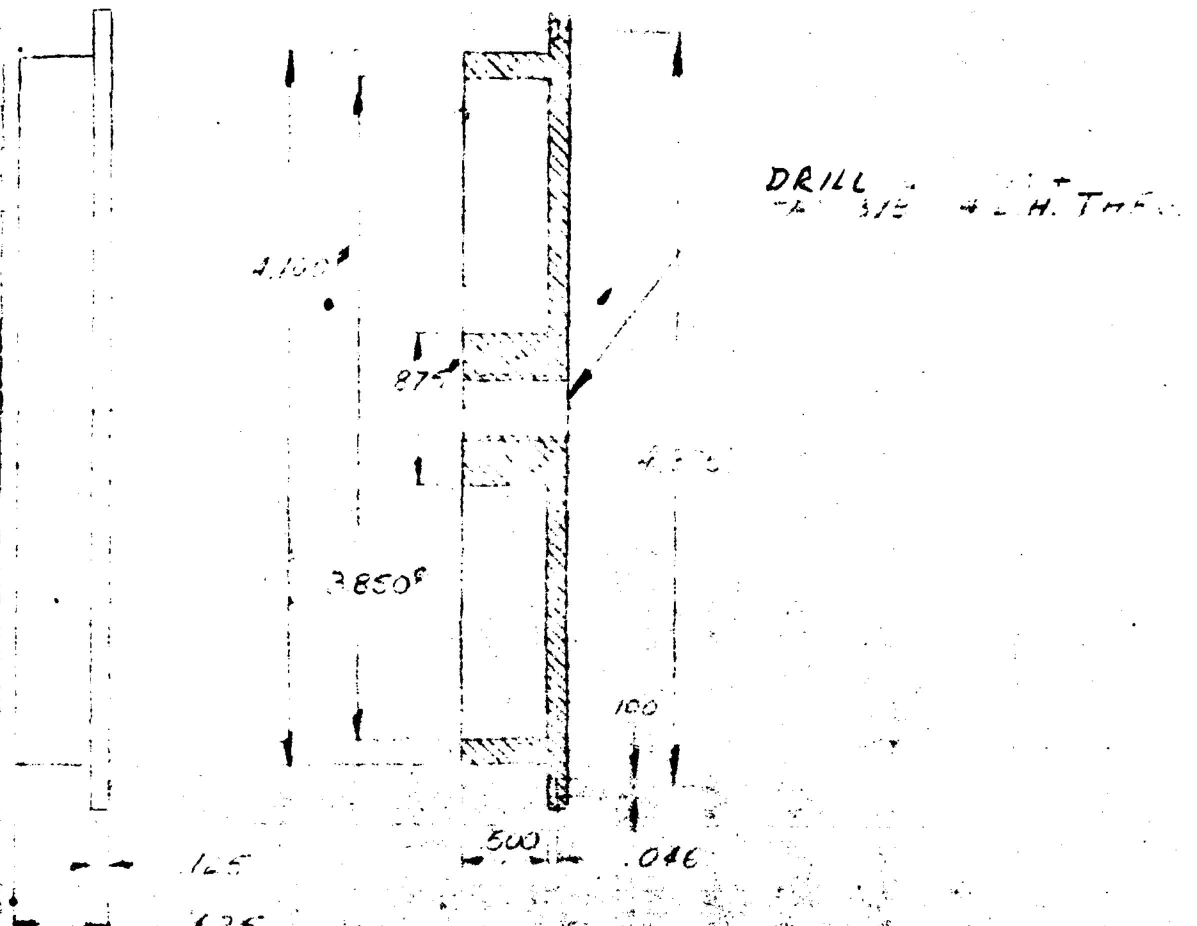
REV	DESCRIPTION	DATE	APPROVED



PARTS LIST


REAM FOR .093 DOWEL
SLIP - FIT X .25 Dp.
A
4.125 Ø
QTY REQD

DWG. NO.



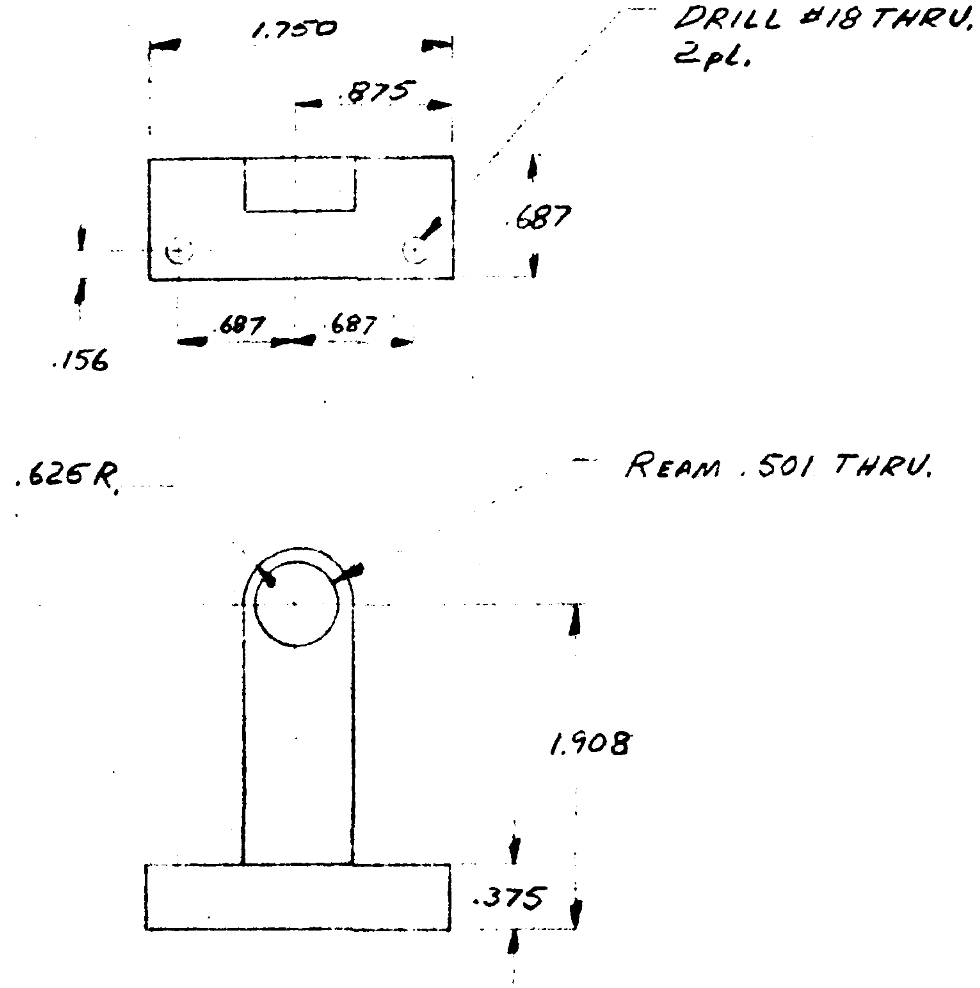
SECTION A-A

QTY REQD	FSCM NO	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE

CONTRACT NO.

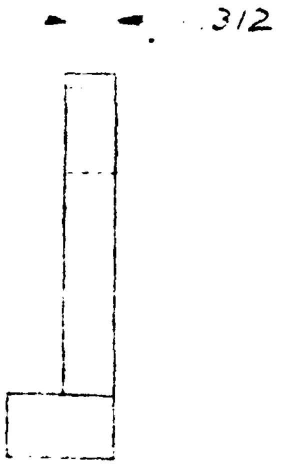


NEXT ASSY	USED ON
APPLICATION	

DWG. NO.	SH	REV.

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED



2

	QTY REQD	FSCM NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE

FRACTIONS ± 1/64 DECIMALS .XX ±.01 .XXX ±.003 ANGLES ± 1°

CONTRACT NO.

MATERIAL: 6061 ALUM.

FINISH: BLK ANOD.

DO NOT SCALE DRAWING

APPROVALS		DATE
DRAWN	[illegible]	6/8/85
CHECKED		
ISSUED		

SUPPORT, MOUNT PLATE

SIZE	FSCM NO.	DWG. NO.	REV.
B		0005-0025	

SCALE Full

SHEET 1 of 1

DATE
FILMED
5-8